SCIENCE

Vol. 109   No. 2843   Friday, June 24, 1949

CONTENTS

Loyalty and Security Problems of Scientists:
A Summary of Current Clearance Procedures[1]

Scientists' Committee on Loyalty Problems,[2]

A Committee of the Federation of American Scientists
14 Battle Road, Princeton, New Jersey

A SCIENTIST who is considering a job with the federal government, or with an industrial laboratory or university which has financial support from the government, may need loyalty or security clearance from the appropriate government agency. If the work is "classified,"[3] he will certainly need security clearance, and if he works for the government directly on any kind of job, loyalty clearance is required. But even if he anticipates only unclassified work, either in industry or at a university, he may still need some sort of clearance.

The clearance requirements and the procedures involved are varied and not well understood by most scientists, perhaps not even by a prospective employer. Since government-supported research is rapidly becoming the rule rather than the exception, there is a growing need for scientists to familiarize themselves with a type of problem which has hitherto been in the province of the legal profession.

Among the many questions about which there is considerable confusion is the distinction between *loyalty* and *security* clearance. According to current usage of the term, loyalty clearance refers to the requirements placed upon all government employees (more than two million) by the President's order of March 21, 1947 (*7*). According to this order, *all* persons employed by or seeking employment from the federal government must be subjected to a loyalty investigation; no distinction is made between persons who do classified work and those who do not. On the other hand, security clearance refers to the special requirements of certain "sensitive security areas," and applies to persons who work with classified or restricted information. Factors considered in processing security cases include questions of loyalty but also include questions of personal reliability, emotional stability, etc. Altogether, six government agencies— viz., the Atomic Energy Commission, the Departments of Army, Navy, and Air Force, the State Department, and the Central Intelligence Agency—have their own separate security clearance procedures. The last two agencies mentioned do not ordinarily employ scientists. In addition, persons working on contracts from these agencies must have security clearance if they have access to classified or restricted information. The clearance procedures of the Atomic Energy Commission apply to both commission employees and employees of AEC contractors. The three departments of the National Defense Establishment, however, have a different set of procedures for employees of their contractors.

Although these security clearance procedures apply in principle only to persons who actually have access to classified or restricted information, some industrial laboratories and even some university laboratories have considered it convenient, from an administrative point of view, to request security clearance of *all* their employees, regardless of whether or not they are doing classified work. Thus, the impact of the security program is being felt by a relatively large group of scientists.

THE LOYALTY PROGRAM

Among the numerous government departments and agencies which administer the requirements of the President's loyalty order, the Departments of Commerce, Interior, Agriculture, Navy, and Air Force, the Federal Security Agency, and the Federal Communications Commission are of particular interest to scientists. Such bureaus as the Bureau of Standards, the Civil Aeronautics Administration, the Weather Bureau, the Bureau of Mines, the Geological Survey, the Public Health Service, the National Institutes of Health, and the Food and Drug Administration are included in the departments and agencies mentioned. The formal loyalty procedures of all these are uniform, although the administrative personnel involved naturally varies considerably.

The procedure used is this. The Federal Bureau

---

[3] "Classified" information is that which has been adjudged "top secret," "secret," "confidential," or "restricted." (The Atomic Energy Commission uses the term "restricted" instead of "classified.")

of Investigation makes a check of all available records—FBI, Civil Service Commission, Military and Naval Intelligence, and House Committee on Un-American Activities—to see whether there is any derogatory information concerning the individual. If no such information is found, nothing further is done. Whenever any derogatory information is discovered, the FBI carries out a "full field investigation" and then turns the file over to the agency or department in the case of employees or to a Regional Loyalty Board of the Civil Service Commission in the case of applicants. Each federal department and agency has set up a loyalty board to review cases of their employees; adverse decisions made by these boards may be appealed to the department or agency head or a person designated by him. Final appeals from both employees and applicants may be made to a special Loyalty Review Board set up in the Civil Service Commission. This Loyalty Review Board has acted as the administrative head of the entire loyalty program (8).

As of September 18, 1948, 2,136,501 loyalty investigations had been completed and 4,363 "full field investigations" conducted. The results of hearings held as of September 18, 1948, are shown below (3):

Hearing Board	Favorable	Unfavorable
Agency boards (employees)	1122	69
Agency head (appeals by employees)	6	15
Regional CSC board (applicants)	159	17
Loyalty Review Board (final appeal)	2	6

In all these loyalty hearings, the employee or applicant was presented with a statement of the charges against him and was permitted to be represented by a lawyer and to present evidence through witnesses or otherwise. Strict legal rules of order, however, were not adhered to; in particular, confrontation or cross-examination of witnesses was seldom allowed. The standard for refusal of or removal from employment, according to the original executive order, is that ". . . on all the evidence, reasonable grounds exist for belief that the person involved is disloyal. . . ." Activities which were to be considered included sabotage, espionage, treason, advocacy of revolution by force, unauthorized disclosure of information, and serving the interest of another government. In addition, the doctrine of "guilt by association" was included, since "Membership in, affiliation with or sympathetic association[4] with . . ." organizations declared "subversive"[5]

[4] This term is not further defined (See 6, page 41).
[5] See 6, page 39.

by the Attorney General were possible causes for a finding of disloyalty. Organizations so designated have been given no avenue of appeal. In the case of membership in the Communist Party and certain other organizations, the Attorney General has declared that dismissal was mandatory under the Hatch Act (Public Law 252—76th Congress) (13).

THE ATOMIC ENERGY COMMISSION

The Atomic Energy Act of 1946 (15) requires the AEC to secure an FBI report on all persons having access to restricted data and to determine that such access will not endanger national security. On April 15, 1948, the commission announced its "Interim Procedure" for security clearance of employees (1). The FBI report is first reviewed in the appropriate AEC field office; the Manager of Directed Operations may grant or deny clearance or may refer the case to the Director of Security in Washington.

To aid the manager in reaching a decision, the commission set up a set of criteria on January 5, 1949 (9). Two categories of information were described. The first category included classes ". . . which establish a presumption of security risk," and in such cases the local manager can deny clearance or refer the case to the Director of Security in Washington. Included in this category are sabotage, espionage, treason, sedition, association with foreign agents, membership in organizations declared subversive by the Attorney General (provided the individual did not withdraw when the organization was so identified, or otherwise establish his rejection of its subversive aims), advocacy of revolution by force, deliberate omission of "significant information" from personnel questionnaires, violation of security regulations, insanity, conviction of criminal offenses, and habitual drunkenness. The second category includes more questionable types of information; in these cases the local manager may grant or deny clearance. Included in this list are "sympathetic interest in totalitarian, fascist, communist, or other subversive political ideologies," "sympathetic association" with communists or members of other "subversive" organizations (as defined by the Attorney General), identification with subversive "front" organizations or organizations "infiltrated" with subversive persons (when there is additional evidence that the individual's views agree with those of the subversive "lines"), residence of relatives in certain foreign countries, "close continuing associations" with persons having "subversive interests and associations," (as defined above), conscientious objection to war except on religious grounds, manifest carelessness, and homosexuality.

When a preliminary decision has been made to refuse security clearance, an employee is presented

with a statement of charges and is permitted a hearing before a local Personnel Security Board, which then makes a recommendation to the Manager of Directed Operations. If the decision is still unfavorable to the employee, he may appeal to the Personnel Security Review Board, which until recently was headed by ex-Supreme Court Justice Owen J. Roberts. Charles Fahy, former Solicitor General of the United States, is now head of this board.

According to the Fifth Semiannual Report of the AEC (January, 1949) (10), the Commission has taken action on more than a hundred thousand candidates for clearance, but fewer than two thousand of these involved serious questions concerning eligibility. No recent figures on the number of hearings held have been released, but as of July 15, 1948, fifteen hearings for employees were conducted by local boards (11). At that time, five were granted clearance, and one was refused clearance.

Applicants for AEC jobs or for jobs with AEC contractors have not been allowed any of these procedural safeguards, however. Except in a few cases, no statements of charges or hearings of any sort have been given. During recent months the commission has been considering extending its procedures to include applicants (10, 11), but at the date of this writing no action has been taken.

Departments of Army, Navy, and Air Force

Public Law 808, passed by the 77th Congress, gave the "power of summary dismissal" to the heads of these departments and thus established the basis for security clearance requirements (14).

Like all other government employees, civilian employees of the Army Department are required to have a loyalty clearance in accordance with the President's order. The Army may require a more complete investigation of employees to be assigned to sensitive activities, however, and such clearance is called security clearance (5). The removal procedures of Executive Order 9835 are not followed in any case. If an employee is discharged he is given at that time a statement of reasons for the action and may appeal the decision to the Secretary of the Army's Security Review Board. As of October 1, 1948, 79 employees of the Army Department had been removed under these procedures and 16 of them had been reinstated after appeal, according to information obtained from the Office of the Secretary of the Army.

The Department of the Navy requires only loyalty clearance of all its employees, and the procedures used are similar to the loyalty procedures of other government agencies (12). When an employee has access to classified materials or information, however, security clearance is required, and in that case no hearings at all are provided. In accordance with the requirements of Public Law 808, passed by the 77th Congress, the employee is presented with a statement of the reasons for his dismissal and he may file a statement protesting such action if he wishes.

The Department of the Air Force has a still different set of procedures in which loyalty and security are considered together (2). A finding of disloyalty necessarily implies that the employee is a "security risk" but not vice versa, according to these procedures. In all cases, two hearings are possible: one before a Loyalty-Security Hearing Board and, in the event of an adverse decision, another before the Loyalty-Security Review Board. Further, a finding of disloyalty may be appealed to the Civil Service Com-

TABLE 1

SUMMARY OF PROCEDURAL SAFEGUARDS

	Loyalty program		Security programs					
	E*	A†	AEC E*	A†	Army	Navy‡	Air Force	IERB§
Statement of charges presented to accused?	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Hearing held before action taken?	Yes	Yes	Yes	No	No	No	Yes	No
Number appeal hearings available.	2	1	1	0	1	0	1	1
Civilian boards?	Yes	Yes	Yes	....	Yes	....	Yes‖	No
Counsel permitted?	Yes	Yes	Yes	....	Yes	....	Yes	Yes
Can accused introduce evidence?	Yes	Yes	Yes	....	Yes	....	Yes	Yes
Confrontation of witnesses permitted?	No	No	No¶	....	No	....	No	No
Transcript of hearing given to accused?	Yes	Yes	Yes	....	Yes	....	Yes	No
Are hearings unclassified?	Yes	Yes	Yes	....	Yes	....	Yes	No

* E—Employee.
† A—Applicant.
‡ Most Navy Department cases are loyalty cases, not security cases (See Navy Civilian Personnel Guide 29).
§ Industrial Employment Review Board (Army, Navy, and Air Force contracts).
‖ The Air Force regulations stipulate that a majority of the board be civilians (See Air Force Regulation No. 40–12. September 15, 1948).
¶ Confrontation has been permitted in some cases. (See AEC Fourth Semiannual Report.)

mission Loyalty Review Board. However, even if the Loyalty Review Board issues a favorable decision, the department may still consider the employee to be a security risk.

Applications for jobs in these three departments are handled by the Civil Service Commission and so loyalty clearance is required, as in the case of other government departments and agencies described before. Once employed, however, a person may require additional security clearance under the procedures just stated.

ARMY-NAVY-AIR FORCE CONTRACTS

The Army, with the concurrence of the Navy and Air Force, has set up security clearance procedures for employees of contractors of the Army, Navy, and Air Force (4). Designated military officials may grant clearance directly, but doubtful cases are referred to the Army-Navy-Air Force Personnel Security Board, which may direct that the employee be discharged or suspended. This board holds no hearings. Any action may be appealed by the person involved to the Industrial Employment Review Board, in the office of the Provost Marshall General. A hearing before this board is possible only in Washington,

D. C. The board consists of representatives, generally military men, from each of the three departments. No provision is made for the presentation of charges to the individual. The entire hearing is classified and no records or notes on the hearing may be kept by the individual or his lawyer. No further appeals are possible.

All of the procedures that have been described here differ from ordinary legal procedure in this country in at least four major respects (6): (1) no separation between the executive and judicial responsibilities is made in the processing of any loyalty or security cases, (2) no provision is made for a hearing board to write a specific finding of fact after a hearing, (3) confrontation and cross-examination of adverse witnesses are rarely permitted, and (4) the hearings are always closed to the public.

The procedural safeguards, the rights and privileges of individuals, are of particular interest to those scientists who may be involved in clearance problems. Thus, the chief items of the various procedures are summarized in Table 1. Such a condensation clearly cannot be used as the sole basis for judging and comparing various procedures, but may be useful as an index for further inquiry.

References

1. A. E. C. *Interim Procedure,* April 15, 1948.
2. Air Force Regulation No. 40–12, Sept. 15, 1948.
3. Civil Service Comm. Loyalty Review Board, mimeo. report.
4. Dept. of the Army Memo. No. 380–5–10, April 2, 1948; changes on August 9, 1948.
5. Dept. of the Army Circular No. 100, April 9, 1948.
6. EMERSON, T. I. and HELFELD, D. M. *Yale Law J.,* 1948, 58, pp. 1–143.
7. *Fed. Register,* Executive Order 9835, 1935, 12; *Code of Federal Regulations,* Title 3, Chap. II.
8. ———, Regulations of Loyalty Review Board, (Dec. 17,

1947). 13, 253 (corrections, p. 308); also *Code of Fed. Regulations,* Title 5, Chap. II.
9. ———, 14, 42.
10. U.S.A.E.C. 5th Semiannual Rep., G.P.O. (1949).
11. ———, 4th Semiannual Rep., G.P.O. (1948).
12. Navy Civilian Personnel Guide 29, March 2, 1948; changes on April 6, July 6, and Sept. 16, 1948.
13. U. S. Statutes, 53, 1147; *U. S. Code,* 18, 61; statement of Att. Gen., Memo. No. 10, Loyalty Review Board, June 2, 1948.
14. ———, 56, 1053; *U. S. Code,* 5, 652.
15. ———, 60, 755.

Biological Synthesis of Radioactive Silk[1]

Paul C. Zamecnik, Robert B. Loftfield, Mary L. Stephenson, and Carroll M. Williams

The Medical Laboratories of the Collis P. Huntington Memorial Hospital and the *Chemical and Biological Laboratories of Harvard University*

FIBROIN, THE PROTEIN OF SILK, has been a classical object of study in attempts to elucidate the structure of proteins because it is stable and easily isolated and its composition is con-

stant. Numerous and detailed analyses of its component amino acids (1–3) have revealed that glycine and alanine are present in exceptional concentrations, accounting, in fibroin hydrolyzates, for about three-quarters of the total number of amino acid residues and for about two-thirds of the total weight of the residues (1, 2). These unusual properties of fibroin, and the availability of C^{14}-labeled glycine and alanine

FIG. 1. Cecropia cocoon with a pupal stage of the insect removed therefrom.
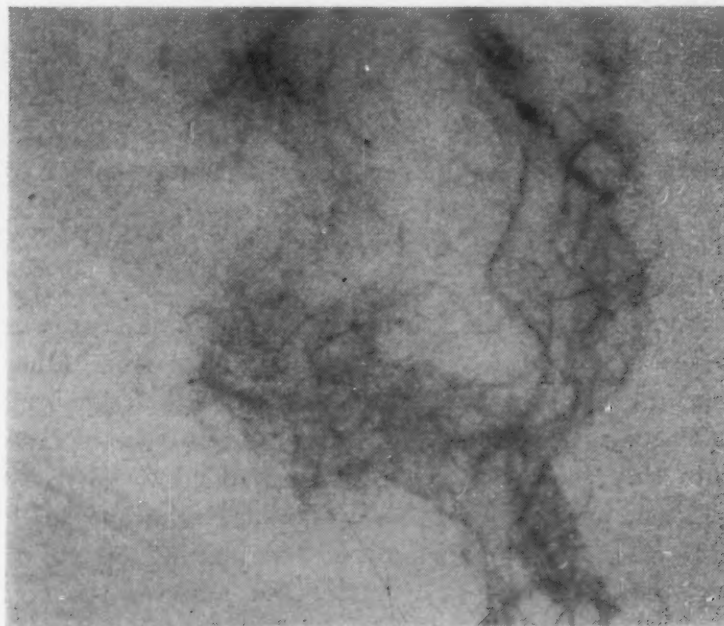
FIG. 3. Radioautograph of silk fibers teased from a radioactive cocoon (mg. 11×).

(4, 5), suggest a possible approach to the biological synthesis of a stable, homogeneous, radioactive protein.

As a first step in this direction we have tested the ability of the giant silkworm, *Platysamia cecropia*, to incorporate radioactive glycine and alanine into the silk it synthesizes. To this end, 0.05 cc of a mixture of radioactive glycine and alanine was injected into the body cavity of a mature silkworm (animal A). A total of 27,000 counts per minute was injected, as measured by an end window Geiger-Müller counter with a counting efficiency of about 8 percent under conditions described previously (8). The injection contained 0.013 mg of C^{14}-carboxyl-labeled glycine with an activity of 18,000 cpm and 0.02 mg of C^{14}-carboxyl labeled DL-alanine, with an activity of 9,000 cpm.

Following the injection, the silkworm continued to feed normally for 24 hours. It then began spinning the cocoon shown in Fig. 1. A thin piece of cocoon fabric, removed and placed under the Geiger-Müller counter, exhibited radioactivity. A similar result was obtained with a silkworm (animal B) injected with 0.05 cc of a solution containing 18,000 cpm in 0.04

mg of C^{14}-carboxyl-labeled DL-alanine alone.

Fragments of cocoon from each insect were placed against unexposed film (Du Pont dental film No. 552-1 and No. 552-2 [cf. 6]) and stored for periods of one to four weeks in the dark. The films were then developed for seven minutes at 68° F. Invariably, radioautographs which revealed details of the pattern of the silk fibers were obtained (cf. Figs. 2 and 3).

In order to test whether the radioactivity of the silk was actually present in the component amino acids, a fragment of cocoon A (73 mg) was cut into small pieces and homogenized into tiny fragments in water. The suspension was precipitated in 10-percent trichloroacetic acid, washed with trichloroacetic acid, and hydrolyzed overnight in an autoclave with the aid of 6 N hydrochloric acid. The ninhydrin procedure (7) was then performed on the protein hydrolyzate. Duplicate counts of the barium carbonate precipitate revealed 160 and 150 cpm per 0.1 mM $BaCO_3$ (8). Thus the radioactivity was shown to be present in the α-carboxyl group of some amino acid associated with the silk fibers.
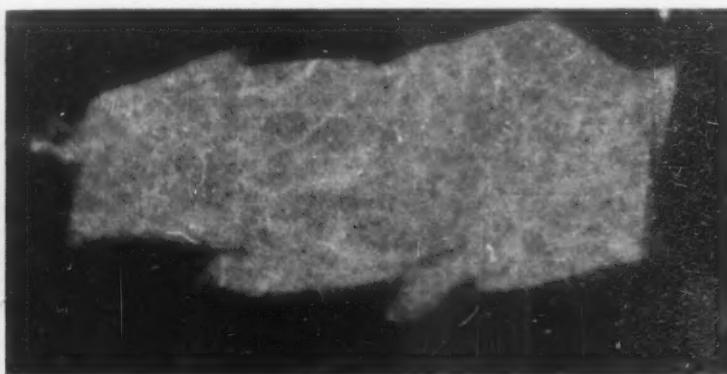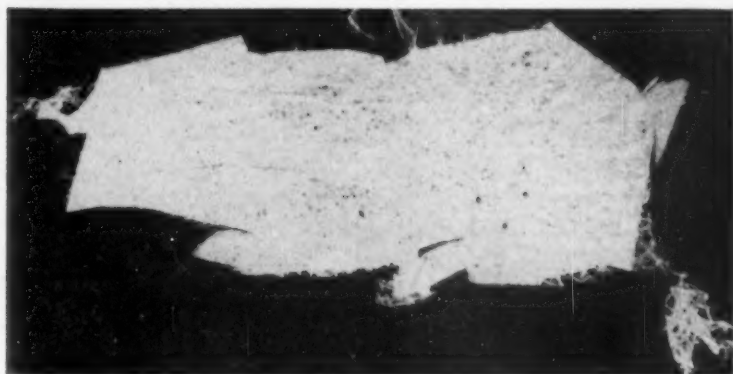
FIG. 2. a) Fragment of cocoon (mg. 3.5×). b) Radioautograph of the same fragment.

The possibility remained, however, that the labeled amino acids might be adsorbed onto the silk fibers, rather than incorporated into the peptide chain structure of the protein itself. Efforts were therefore made to dissolve the fibroin and determine whether or not the reprecipitated protein was still radioactive. There was not, unfortunately, a sufficient quantity of labeled silk to carry out such a procedure. Accordingly, 0.1 g of the labeled cocoon (animal A) was added to 0.9 g of inert silk, obtained from other cocoons, and the mixture was degummed by boiling with soap. The dried, degummed fibroin was then cut into tiny pieces with scissors and added to 43 cc of copper hydroxide-ethylene diamine solution [6 g $Cu(OH)_2$ and 3 g ethylene diamine in 100 cc of aqueous solution] (2). After ten minutes the silk had been partially dissolved. The suspension was then neutralized with 1.25 N acetic acid to pH 8, and filtered with suction. The clear, deep blue filtrate, containing dissolved silk, was added slowly to six volumes of acetone with stirring. The resulting precipitate was collected on a small Büchner funnel and washed with acetone and ether. The flaky, pale purple precipitate was suspended in 15 cc of water; the water turned a dark blue. The suspension was filtered onto a small Büchner funnel, and the light brown precipitate was washed with water and dried in an oven. Thirteen mg of this reprecipitated silk fibroin was hydrolyzed overnight in 1 cc of 6 N HCl in an autoclave. A ninhydrin determination was performed on the fibroin hydrolyzate, the evolved carbon dioxide being collected as barium carbonate and counted in the usual manner (8). There were 12.7 cpm per 0.1 mM barium carbonate when corrected to 0.1 mM thickness (5.4 mg per sq cm with our apparatus). Taking into account the tenfold dilution of the original labeled silk with unlabeled silk, there were 127 cpm per 0.1 mM of hydrolyzate of labeled silk fibroin.

As a result of these findings, we were encouraged to try an experiment *in vitro* on protein synthesis in the isolated silk gland of the insect. Two silkworms, in the final instar, were dissected and the four silk glands removed. These glands were incubated in a Warburg flask in 1.1 cc of Krebs-Ringer-phosphate medium of pH 7.4, which contained in addition 0.04 M sodium pyruvate and 0.37 mg of C^{14}-carboxyl-labeled glycine with an activity of 10,000 cpm. After 3½ hours' incubation at 37° C in an atmosphere of oxygen, the experiment was terminated. The glands were homogenized and washed, and the proteins were precipitated, hydrolyzed, and assayed for the presence of radioactivity. A total of 74 cpm was found in the 0.067 mM sample of $BaCO_3$, or 93 cpm per 0.1 mM of $BaCO_3$ as corrected to standard conditions. This experiment implies that the amino acids were incorporated into protein in the living silkworm gland *in vitro*. Since the fibroin was not isolated, there is no certainty, however, that silk rather than some other protein was synthesized under the conditions of the experiment.

The term "protein synthesis" is used in a broad sense. There remains the possibility that the labeled amino acids may have entered preformed fibroin molecules by "exchange" rather than by participation in a true synthesis of the fibroin molecule *de novo*. There may also be formation of side chain peptide bonds between the labeled amino acids and either amino or carboxyl groups not in the alpha position. These several processes may have conceivably all taken place under the experimental conditions.

References

1. BERGMANN, M. and NIEMANN, C. *J. biol. Chem.*, 1938, **122**. 577.
2. COLEMAN, D. and HOWITT, F. O. *Proc. roy. Soc.*, 1947, **190**, 145.
3. FISCHER, E. and ABDERHALDEN, E. *Ber. chem. Ges.*, 1907, **40**, 3544.
4. FRANTZ, I. D., JR., LOFTFIELD, R. B., and MILLER, W. W. *Science*, 1947, **106**, 544.
5. LOFTFIELD, R. B. *Nucleonics*, 1947, **1**, 54.
6. RUDENBERG, F. H., COWING, R. F., and SPALDING, C. K. *Nucleonics*, 1948, **3**, 52.
7. VAN SLYKE, D. D., MACFADYEN, D. A., and HAMILTON, P. *J. biol. Chem.*, 1941, **141**, 671.
8. ZAMECNIK, P. C., FRANTZ, I. D., JR., LOFTFIELD, R. B., and STEPHENSON, M. L. *J. biol. Chem.*, 1948, **175**. 299.

TECHNICAL PAPERS

The Conversion of β-Erythroidine to Derivatives of the Desmethoxy Series and Some Pharmacological Properties of Apo-β-Erythroidine[1, 2]

G. L. Sauvage, F. M. Berger, and V. Boekelheide

Departments of Chemistry and Pediatrics,
School of Medicine and Dentistry,
University of Rochester

β-Erythroidine differs from almost all other peripheral curariform agents in that it is much less effective when employed as the quaternary ammonium salt than when employed as the tertiary amine hydrochloride (11). Inasmuch as it is generally thought that the quaternary ammonium ion is very important in conferring curariform activity (4), the structural unit responsible for the curariform activity of β-erythroidine must, therefore, be of a different type from that of the usual curariform agent. We have made some preliminary investigations of β-erythroidine in the hope of establishing some relationship between structure and activity, and it is the purpose of this note to report the discovery of some new derivatives of β-erythroidine and to describe some of the unusual pharmacological properties of one of these derivatives, apo-β-erythroidine.

β-Erythroidine was first isolated and characterized by Folkers and Major (8). Following this excellent work, Folkers and Koniuszy (6) in 1939 and Folkers, Koniuszy, and Shavel (7) in 1941 reported on some chemical studies of β-erythroidine. As yet, no experimental details of this work have been published, and it is fair to say that the structure of β-erythroidine is still largely unknown.

In 1946 Dietz and Folkers (5) reported a spectrophotometric method of analysis for β-erythroidine based on the fact that the alkaloid, after treatment with sulfuric acid, gives a purple color with ferric chloride. We have investigated further the action of acids on β-erythroidine and have found that, depending on the conditions employed, any one of three different isomeric derivatives of β-erythroidine may be obtained. The conversion of β-erythroidine to these derivatives was accomplished by the following procedures.

When β-erythroidine ($C_{16}H_{19}NO_3$) was treated with hydrogen fluoride at room temperature there was obtained, after isolation and purification, a white, crystalline solid, mp 108–109° C, having the empirical formula, $C_{15}H_{15}NO_2$ (*Analysis*: Calculated for $C_{15}H_{15}NO_2$: C, 74.66;

H, 6.26; found: C, 74.74; H, 6.06). This product differs from β-erythroidine by the elements of methanol (CH_4O), and it would appear to have been formed by the simple loss of a methoxyl group with introduction of a double bond. In support of this view β-erythroidine was found to contain one methoxyl group (*Analysis*: Calculated for $C_{16}H_{19}NO_3$: 1-OCH_3, 11.35; found: OCH_3, 11.10) whereas the product from treatment of β-erythroidine with hydrogen fluoride was found to contain no methoxyl groups. Therefore, we have named this product, desmethoxy-β-erythroidine. Desmethoxy-β-erythroidine does not give a color with ferric chloride.

On the other hand, when β-erythroidine was heated to 120° C with either phosphoric or sulfuric acid, the product isolated from the reaction mixture after this more drastic treatment was a solid, which, after crystallization from ethanol, melted at 132–132.5° C. This compound was shown (*Analysis*: found: C, 74.94; H, 6.27) to be isomeric with desmethoxy-β-erythroidine, but it has quite different properties and gives a violet color with ferric chloride. We have designated this compound, therefore, as apo-β-erythroidine.

Some idea of the relationship of desmethoxy-β-erythroidine to apo-β-erythroidine was obtained when it was found that phosphoric acid at 80° C converted β-erythroidine to desmethoxy-β-erythroidine and that desmethoxy-β-erythroidine, in turn, was converted by phosphoric acid at 120° C to apo-β-erythroidine. It appears that the conversion of β-erythroidine to apo-β-erythroidine involves rearrangement as well as the loss of a methoxyl group.

Attempts to purify apo-β-erythroidine by chromatography led to still another product. This new product, mp 146–147° C, although isomeric with apo-β-erythroidine and desmethoxy-β-erythroidine (*Analysis*: found: C, 74.52, 74.81; H, 6.20, 6.39) has quite different spectra and properties from either of them. For reference it has been named iso-apo-β-erythroidine. The nature of the structural relationships of these three desmethoxy derivatives of β-erythroidine is of considerable interest and will be discussed in fuller detail elsewhere.

Desmethoxy-β-erythroidine, apo-β-erythroidine, and iso-apo-β-erythroidine have been tested for pharmacological activity, and although desmethoxy-β-erythroidine and iso-apo-β-erythroidine presented little of interest, apo-β-erythroidine showed quite unusual properties.

An intraperitoneal injection of apo-β-erythroidine to mice in doses of 150 mg per kg caused flaccid paralysis and loss of postural reflexes. The hind legs and posterior half of the body became affected first and remained paralyzed longer than the front limbs and neck muscles. During paralysis respiration remained adequate but was decreased in rate and increased in depth. Faradic stimulation of the sciatic nerve caused contraction of the paralyzed limbs. Paralysis was not preceded by excitation and was followed by complete recovery of muscular power.

The paralyzing effect of apo-β-erythroidine was similar to that observed after administration of benzimidazole
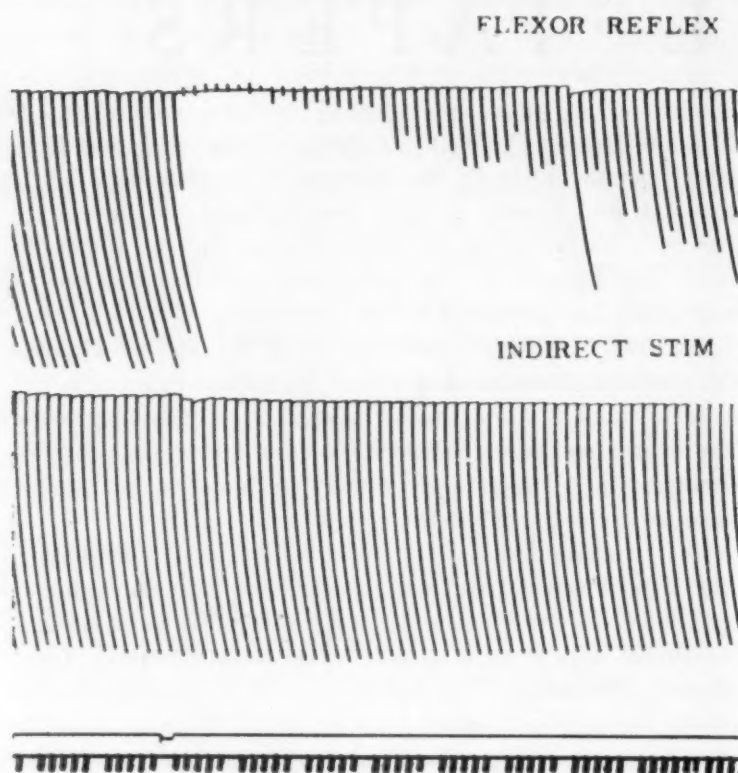
FLEXOR REFLEX

INDIRECT STIM

FIG. 1. Effect of apo-β-erythroidine on the flexor reflex and indirect excitability of the muscle. Tracing from above downwards: 1) flexor reflex; 2) stimulation of gastrocnemius muscle through its nerve; 3) signal line and 4) time at 10-sec intervals.

At the signal 20 mg of apo-β-erythroidine was injected into the external jugular vein.

(9), myanesin (2), and glyketal (1). It differed from these agents in producing paralysis of much longer duration. The mean duration of paralysis with doses of 180 mg per kg was 6 min for myanesin and 35 min for apo-β-erythroidine. After 250 mg per kg of apo-β-erythroidine paralysis lasted for several hours. Death after toxic doses of apo-β-erythroidine was due to respiratory arrest. In mice the mean lethal dose was more than twice as large as the mean paralyzing dose.

Analysis of the pharmacodynamic effects of apo-β-erythroidine in cats showed that the compound did not block transmission at the myoneural junction. It produced paralysis by a depressant effect on the central nervous system. Two neuronal spinal reflexes such as the knee jerk were not affected but multineuronal reflexes such as the flexor reflex were selectively depressed by small doses of the drug. This effect together with the lack of curare-like action of the compound is illustrated in Fig. 1.

The results indicate that apo-β-erythroidine has a selective depressant action on the interneurons. It resembles in this respect other interneuronal blocking agents (1, 2, 9). The fact that four chemically different substances produce similar central effects and act at the same site is of great interest. They are likely to act by blocking some important but as yet unknown mechanism of transmission in the central nervous system. None of these substances interferes with the action of acetylcholine as a transmitter of nervous impulses.

It has been suspected for some time that β-erythroidine, apart from its curare-like action, also possessed central depressant properties (3, 10). These two properties have been dissociated in apo-β-erythroidine, which lacks the peripheral action but still retains the central depressant properties of β-erythroidine.

References

1. BERGER, F. M., BOEKELHEIDE, V., and TARBELL, D. S. Science, 1948, 108, 561.
2. BERGER, F. M. and BRADLEY, W. Brit. J. Pharmacol., 1946, 1, 265.
3. BURMAN, M. S. J. Pharmacol., 1940, 69, 143.
4. CRAIG, L. E. Chem. Rev., 1948, 42, 285.
5. DIETZ, E. M., and FOLKERS, K. J. Amer. pharm. Ass., 1946, 35, 48.
6. FOLKERS, K. and KONIUSZY, F. Abstracts of papers, Amer. Chem. Soc., April, 1939, p. 15.
7. FOLKERS, K., KONIUSZY, F., and SHAVEL, J. Abstracts of Papers, Amer. Chem. Soc., September, 1941, p. 30.
8. FOLKERS, K. and MAJOR, R. T. J. Amer. chem. Soc., 1937, 59, 1580.
9. GOODMAN, L., GILMAN, A., and HART, N. Fed. Proc., 1943, 2, 80.
10. HARVEY, A. M. and MASLAND, R. S. J. Pharmacol., 1941, 73, 304.
11. UNNA, K., KNIAZUK, M., and GRESLIN, J. G. J. Pharmacol., 1944, 30, 39.

Surface Action in 2,4-D Sprays[1]

D. W. Staniforth and W. E. Loomis

Department of Botany, Iowa State College, Ames

A number of workers (1–4) have reported increased toxicity when various substances are added to sprays of 2,4-dichlorophenoxyacetic acid used as an herbicide. Preliminary results in the summer of 1947, extensively corroborated since, show that the toxicity of these sprays may be increased several fold by adding various surface-acting substances, and suggest that some previously reported results may have been due to similar effects.

Commercial soapless powders with a base of sodium lauryl sulfate have been used most extensively as sur-

TABLE 1

YIELDS OF FLAX SEED WHEN SPRAYED WITH 2,4-D, WITH OR WITHOUT A WETTING AGENT

Spray		Surface tension of spray		Yields in bu/acre*	
		2,4-D only	Plus ½% "D"	2,4-D only	Plus ½% "D"
Water		72 dynes	28 dynes	16.4	17.4
Na salt	—½ lb	58	28	13.6	5.4
	—¼ lb	57	28	18.5	12.2
	—⅛ lb	57	28	16.2	14.6
Amine	—½ lb	53	29	15.4	6.1
	—¼ lb	51	29	15.2	10.7
	—⅛ lb	52	29	15.7	12.8
Ester	—½ lb	34.1	30	11.7	11.2
	—¼ lb	35.0	30	13.5	...
	—⅛ lb	35.7	30	16.4	15.1

* Least significant difference (5%), 3.29 bu/acre.

[1] Paper No. J1654, Iowa agric. Exp. Sta., Project 944.

face-acting compounds. The effects of adding $\frac{1}{2}\%$ of one such preparation to various sprays used on flax at the rate of 10 gal per acre are shown in Table 1. The wetting agent alone had no effect, but when added to the sodium or amine salts of 2,4-D, the yields were reduced seriously at the heavier rates of 2,4-D. The ap-

TABLE 2

STALK REACTIONS AND YIELDS OF CORN SPRAYED WITH THE SODIUM SALT OF 2,4-D CONTAINING VARIOUS WETTING AGENTS

Wetting agent	Surface tension (dynes)	Stalk reaction score	Yield* bu/acre
None (check)	...	0.0	93.5
None (2,4-D)	51	0.7	94.5
"D"—$\frac{1}{4}\%$	29.3	4.0	97.0
"D"—$\frac{1}{4}\%$	28.6	6.5	76.7
"D"—$\frac{1}{2}\%$	28.6	6.0	71.6
"D"—1%	28.9	7.8	53.8
"D"—2%	28.8	7.8	32.5
"V"—$\frac{1}{2}\%$	29.9	6.2	81.3
"AO"—$\frac{1}{4}\%$	28.6	5.5	64.5
"T"—$\frac{1}{2}\%$	29.4	6.5	77.2
"TA"—$\frac{1}{2}\%$	31.5	2.0	94.0

* Least significant difference (5%), 14.6 bu/acre.

pearance of the plots some 10 days after spraying suggested that the mixed sprays would be lethal, but the plants made enough late second growth to produce some seed. The wetting agent did not increase the toxicity of the ester formulation on flax, although in another experiment it did increase injury of corn. These plots were fairly free of weeds and all spray treatments reduced weed growth to an insignificant level.

Corn at the laying-by (10-leaf) stage was sprayed with the sodium salt (monohydrate) at $\frac{1}{2}$ lb per acre in 47 gal water. The effects of various kinds and concentrations of wetting agents on plant reaction and yield are shown in Table 2. Yields again are in bushels per acre; stalk reaction is on a scale of 0 for no response to 10 for all the stalks twisted and bent nearly to the ground. All of the wetting agents except "TA" were approximately equal in giving a significant reduction in yield at $\frac{1}{2}\%$. "TA" was an experimental compound

FIG. 1. New growth on sprayed soybean plants: upper left, water only; lower left, $\frac{1}{2}\%$ "D"; upper right, 2,4-D, 500 ppm; lower right, 2,4-D + $\frac{1}{2}\%$ "D."

of a non-ionic type. In another experiment it was active on soybeans. Most of the surface-active compounds decreased the yield of corn by 10–15% when used alone because of the increased smut infection carried into the meristematic regions. The increased injury with increased percentages of agent "D" needs further investigation. It may represent direct toxicity at rates that reached 8 lb per acre, or it may mean more rapid surface action during the spraying operation. The wetting effect was identical whether the agent was mixed with the 2,4-D spray or applied to the leaves and allowed to dry before spraying with 2,4-D.

The striking effect of a wetting agent in increasing the toxicity of 2,4-D on soybeans is shown in Fig. 1. The plants were wet with a 500-ppm solution of the sodium salt of 2,4-D, except for the growing point, which was covered with a waxed cap. The figure shows the new growth made in the week following spraying. Growing points, and most plants, died when the wetting agent was added, but recovered from the 2,4-D alone.

The toxicity of the sodium and amine salts of 2,4-D to corn, flax, and soybeans has been increased five or more times by adding about 1% of commercial non-soap wetting agents. Since several divergent types of agents have given the effect, it is probably not chemical in nature. Decreased surface tension and increased penetration of the sprays seem to be the probable answer, but it is not a simple relationship. A non-ionic wetting agent was ineffective on corn but active on soybeans. An ionic agent of the lauryl sulfate type gave increased response up to 2.0% of the agent in a dilute 2,4-D spray, even though the spray surface tension did not vary significantly after the first 0.05% of wetting agent was added.

The effect of the surface agent has been to increase the speed and severity of the plant reaction, but not necessarily to hasten death. No corn (moderately resistant) or flax (slightly resistant) plants have been killed by any of the treatments reported here. The effect on weeds is similar to the effect on crops. Resistant weeds show more injury but are not more readily killed. The main effect of the wetting agents, then, is to reduce the selective action of 2,4-D by which it is possible to kill susceptible weeds with little injury to resistant crops.

A special warning is necessary on this point because of the practice of using soap to reduce precipitation of amines in hard water. Excess soap gives results similar to those reported here. The new sequestering agents which prevent precipitation by tying up calcium insoluble acetates appear to be free of this objection.

References

1. HAMNER, C. L. and CHI-KIEN, KIANG.　*Science*, 1948, 107, 572.
2. HAMNER, C. L., LUCAS, E. H., and SELL, H. M.　*Mich. agric. Exp. Sta. quart. Bull.*, 1947, 29, 337.
3. HITCHCOCK, A. E. and ZIMMERMAN, P. W.　*Boyce Thompson Inst.*, 1948, 4, 173.
4. LUCAS, E. H. and HAMNER, C. L.　*Mich. agric. Exp. Sta. quart. Bull.*, 1947, 29, 256.
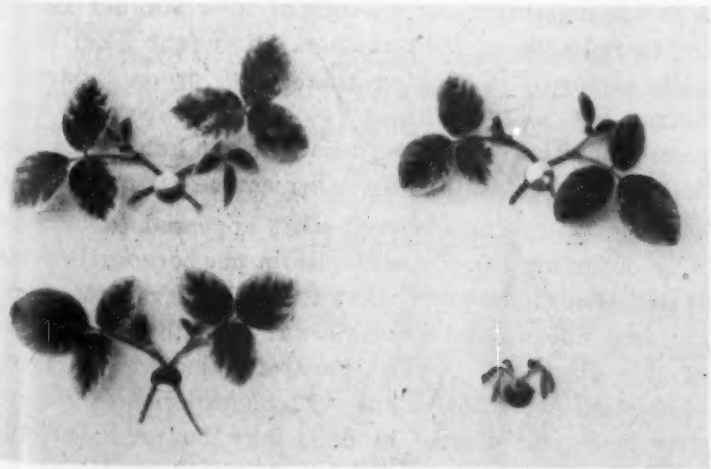
Hemolytic Disease in Newborn Dogs Following Isoimmunization of the Dam by Transfusions[1]

Lawrence E. Young, Donald M. Ervin,
Richard M. Christian, and R. Wendell Davis

*Departments of Medicine and Pediatrics,
The University of Rochester School of Medicine
and Dentistry, Rochester, New York*

Four different isohemagglutinins have been demonstrated in sera of dogs following transfusions with dog erythrocytes containing antigenic factors lacking in their own cells. The factors thus far identified serologically may conveniently be designated as "canine A, B, C, and D" and the corresponding antibodies as "canine anti-A, -B, -C, and -D." In our experience to date, A antibodies have been most easily produced in high titer, and in many respects their behavior *in vitro* is similar to that of Rh antibodies. Possible relationships between antigenic factors in dog red blood cells and factors present in erythrocytes of other species are under investigation. Pending completion of these studies, it is convenient to refer to dog cells containing the canine A factor as "Do-positive" and to cells lacking the canine A factor as "Do-negative."

Observations on hemolytic reactions following transfusion of Do-positive cells into immunized Do-negative recipient dogs and of anti-Do plasma into Do-positive recipients are described in separate reports (*2, 4, 5*). The object of this paper is to record the production of hemolytic disease in four Do-positive puppies born to a Do-negative bitch (mostly pointer) that had been immunized by transfusions of Do-positive cells and then mated with a Do-positive male (mostly German shepherd). Four Do-negative puppies in the same litter showed no evidence of hemolytic disease.

Erythrocytes of the four affected whelps were agglutinated by high dilutions of anti-dog-serum rabbit serum (positive direct Coombs' test), and were also agglutinated when suspended in undiluted normal dog serum, presumably because the cells were coated with Do-antibody. Unsuccessful attempts were made to separate the antibody from the puppies' cells by heating the cells at 48° to 56° C. Plasma drawn from the four unaffected Do-negative whelps agglutinated cells of the sire in a titer equal to that of the maternal serum at the time of delivery. Isoantibodies in the blood of the four affected Do-positive puppies, on the other hand, were apparently completely bound by cells, since plasma from these dogs did not agglutinate the sire's erythrocytes.

The maternal isoantibody titer fell from 1:64 (against

the sire's cells suspended in autologous serum) at the time of mating to 1:4 at the time of delivery. The dam was not transfused during pregnancy, but was given 17 ml of the sire's fresh citrated whole blood intravenously immediately after delivery. Breast milk from the dam agglutinated the sire's red corpuscles in titers considerably lower than those found in the maternal serum during the postpartum period of rising antibody titer. Absorption of isoantibody from the milk by the puppies could not be demonstrated. It is significant that Do-antibodies could no longer be detected in plasma from the unaffected Do-negative puppies on the 9th day, and Coombs' tests on cells of Do-positive affected puppies became negative on the 12th day, despite the fact that all whelps suckled breast milk containing antibody for 24 days.

Erythrocytes from the four affected puppies showed increased susceptibility to lysis in hypotonic solutions of sodium chloride, but spheroidicity of these cells could not be detected in smears or wet preparations. Nucleated red blood cells and reticulocytes were more numerous in most of the smears prepared from blood of the affected puppies than in the Do-negative puppies, but in some instances the differences were not striking.

Only one Do-positive whelp showed icterus of skin and mucous membranes and was found to have distinctly increased concentration of bilirubin in the plasma. This puppy was moderately anemic. Another Do-positive puppy became severely anemic without developing jaundice. Neither icterus nor anemia of significance was found in the other two Do-positive puppies. The severely anemic whelp and a normal litter mate were sacrificed for histologic studies on the third day. The affected animal showed splenomegaly and more marked erythropoiesis in the liver and spleen. The erythroid elements in the bone marrow, liver, and spleen of the affected puppy were also more immature than those in the marrow of the normal litter mate. There was no evidence of kernicterus. The three remaining Do-positive puppies gained weight more slowly than their normal litter mates, but ultimately made complete recovery.

The observations cited are considered sufficient to establish the diagnosis of hemolytic disease of varying severity in the four puppies with erythrocytes containing a factor present in the red cells of their sire but lacking in the red cells of their mother. The four litter mates with erythrocytes lacking this factor were apparently normal. A separate paper (*3*) will describe more completely the observations on this litter and on litters born of dams immunized against other canine factors.

Abelson (*1*) has observed what appeared to be naturally occurring hemolytic disease in newborn dachshunds. It is believed, however, that the present report records the first unequivocal serologic and hematologic evidence of this disease in puppies born of a mother previously immunized by transfusions. These experiences suggest that hemolytic disease in dogs may be produced with some degree of frequency and that studies on this species may aid in clarifying certain aspects of erythroblastosis fetalis as it occurs in human beings. Opportunities for

controlled observations on large litters sired by heterozygous males seem particularly attractive.

In the litter described, the pups had suckled for about two hours before the first blood samples were drawn. Do-positive pups in three subsequent litters were similarly affected, but examinations of the blood before and after suckling revealed that most, if not all, of the Do-antibody was acquired from the dams' milk.

References

1. ABELSON, N. Paper read before Interurban Club, Philadelphia, April 5, 1946.
2. ERVIN, D. M., CHRISTIAN, R. M., DAVIS, R. W., YUILE, C. L., and YOUNG, L. E. Blood. In press.
3. ERVIN, D. M., et al. Blood. In press.
4. YOUNG, L. E., ERVIN, D. M., and YUILE, C. L. (To be published.)
5. YUILE, C. L., et al. (To be published.)

The Antithyroid Factor of Yellow Turnip[1]

E. B. Astwood, Monte A. Greer, and
Martin G. Ettlinger[2]

Joseph H. Pratt Diagnostic Hospital;
Department of Medicine, Tufts Medical School;
and Department of Chemistry, Harvard University

It has been well established that goiter may be induced in laboratory animals by diets of certain vegetables such as cabbage, turnip, or rape. A recent study (2) of the antithyroid effect of various foods in man disclosed marked activity in the yellow turnip or rutabaga, Brassica napobrassica. This antithyroid principle has now been isolated in crystalline form and its structure determined.

The purification of the goitrogen was controlled by antithyroid assay of crude preparations in the rat, and later by measurement of the ultraviolet absorption spectrum. The active substance was released from ground rutabaga root by extraction with cold water, and concentrated by appropriate distribution between ether and alkaline buffers. The concentrates so prepared could be crystallized directly from ether with the aid of seed crystals, which were originally obtained from material that had been further purified by distillation in high vacuum and chromatographic adsorption on alumina. The active principle was isolated in a yield of 0.2 g/kg of root as colorless crystals of formula C_5H_7ONS, mp 50°, $[\alpha]_D^{21} - 71°$ (2% methanol solution). The same substance was obtained from the root of white turnip, and in larger quantities (1–8 g/kg) from the seeds of rutabaga, white turnip, cabbage, kale, and rape. Its antithyroid activity in man approximately equals that of 6-n-propylthiouracil.

Since no pure chemical degradation product could be obtained from the goitrogen, its structure was deduced largely from physical evidence. The compound in aqueous solution was found to be a weak acid (pK$_a$ 10.5) and to have an intense ultraviolet absorption maximum at 240 mμ and log ε 4.24, which was shifted by alkali to 232 mμ, log ε 4.06. In these properties it closely resembled 5,5-dimethyl-2-thioöxazolidone (formula I), a natural product (3) of similar composition. Furthermore, the infrared absorption spectrum of the unknown in chloroform solution exhibited a system of bands at 2.9 μ, 3.15 μ, 6.6 μ (inflected at 6.5 μ), and 8.6 μ, which was found to be highly characteristic of 2-thioöxazolidones, and contained two bands at 10.17 μ and 10.85 μ, indicating the presence of a vinyl group (1). Coupled with the absence of terminal methyl groups, these facts required that the rutabaga goitrogen have the structure of a vinylthioöxazolidone. The observation that treatment of the substance with boiling 4N HCl destroyed optical activity without liberating ammonia strongly suggested the attachment of the oxygen rather than the nitrogen atom to the allylic center of asymmetry. Therefore, the antithyroid factor of rutabaga was considered to be L-5-vinyl-2-thioöxazolidone (formula II):
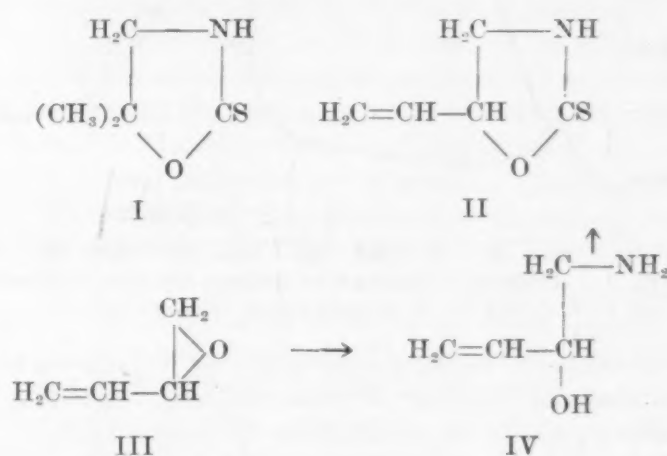
The assigned formula was confirmed by synthesis. Reaction of butadiene 1,2-monoxide (formula III) (4) with ammonia produced a mixture from which a pure aminoalcohol, in all probability 1-amino-3-buten-2-ol (formula IV), was separated as its acid oxalate, mp 131°. Conversion of this aminoalcohol to the dithiocarbamate with carbon disulfide and alkali, followed by cyclization with lead nitrate, furnished DL-5-vinyl-2-thioöxazolidone, mp 63°, which had the same infrared spectrum as the rutabaga factor. L-1-Amino-3-buten-2-ol, obtained by resolution of the racemic aminoalcohol with D-α-bromocamphor-π-sulfuric acid, was similarly transformed into synthetic L-5-vinyl-2-thioöxazolidone, identical with the natural product.

References

1. BARNES, R. B., et al. Anal. Chem., 1948, 20, 402.
2. GREER, M. A. and ASTWOOD, E. B. Endocrinology, 1948, 43, 105.
3. HOPKINS, C. Y. Canad. J. Res., 1938, 16B, 341.
4. KADESCH, R. G. J. Amer. chem. Soc., 1946, 68, 41.

Properties of Barium Titanate in Connection with Its Crystal Structure

G. H. Jonker and J. H. van Santen

Philips Research Laboratories,
Eindhoven, Netherlands

In recent years the uncommon properties of barium titanate (BaTiO₃) and some related compounds have attracted much attention. In rapid succession more than 70 publications of various lengths have already appeared, and the subject has been given even more notice since it has become possible to obtain clear crystals from differ-
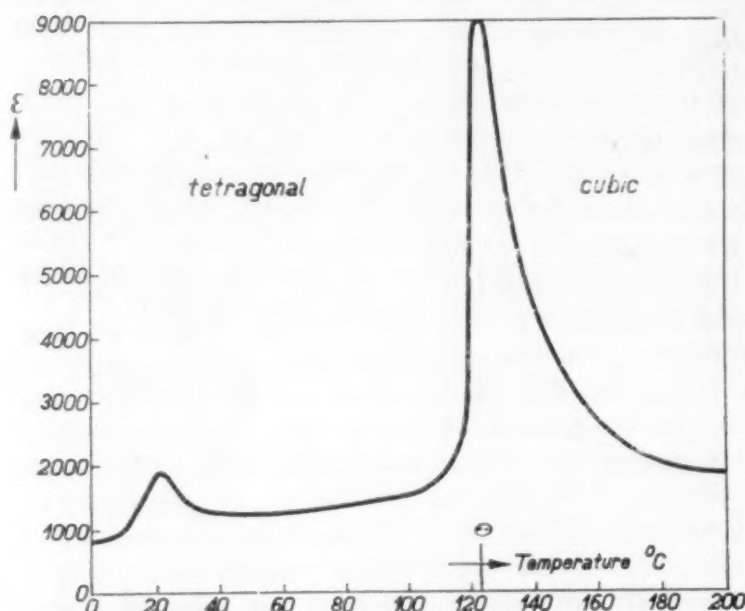

FIG. 1. Dielectric constant of barium titanate measured at low field strengths as a function of temperature.

ent melts (4). In the present paper we will discuss how the abnormal behavior of these dielectric materials is closely related to the structure of the crystal lattice.

First we give a general survey of the well-known properties of BaTiO₃, the influence of the temperature T and the field strength E on the dielectric constant ε. Fig. 1 shows the relation between ε and T, when measured in a weak a-c field at a frequency between 1 kc and 10 mcps. There is one very high peak in ε at $T = 123°$ C and two small ones at $T = 12°$ C and $T = -70°$ C. The temperature of $123°$ C (θ) divides this graph into two temperature regions where BaTiO₃ shows quite different properties. At temperatures above θ the polarization is a linear function of the electric field strength, the dielectric losses are low, and the only remarkable thing is the steep fall of ε with rising T. The dependence of ε on T in this region is given by a very simple relation:

$$\varepsilon = \frac{A}{T - \theta},$$

A being a constant, approximately equal to the reciprocal value of ß, the linear coefficient of thermal expansion.

For BaTiO₃ we find experimentally

$$\varepsilon = \frac{102,000}{T - 396} \text{ and } \beta = 0.95 \cdot 10^{-5}.$$

In the temperature region below θ the properties are completely changed. ε is no longer a constant, but be-

comes dependent on the electric field strength. The electric polarization can be considered as composed of two parts: a linear part caused by electronic and ionic displacements, and a nonlinear part which can be saturated at high field strength and which consists of dipole orientation (Fig. 2). The nonlinear part gives only a small contribution to the polarization at low field strengths; at higher field strengths, however, the contribution of this part gradually develops until saturation is reached. The final slope of the hysteresis loop is approximately equal to the initial slope of the initial curve. The dipole contribution causes hysteresis and remanence of polarization, just as in the case of a ferromagnetic material.

The temperature of the peak of ε can be largely influenced by preparing mixed crystals with some other titanates, stannates, and zirconates. Only in the case of mixtures with PbTiO₃ do we find an increase of θ, all other additions reducing the value of θ. Solid solutions of these materials are possible, as they all have the same crystal structure, the so-called perovskite structure (perovskite is the mineral CaTiO₃). Fig. 3 gives a general picture of the crystal lattice, with a Ti-ion in the center, O-ions at the centers of the faces, and Ba-ions at the corners. In general this is a cubic lattice, but Goldschmidt (2) has already shown that there are only few really cubic perovskites. The possibility that three different types of ions will fit in a parameterless cubic structure is not large. Strontium titanate is an example. The unit cell of BaTiO₃ shows a slight tetragonal deformation at temperatures up to θ. At this temperature a transition to the cubic form takes place. In the following sections we will discuss the relation between the crystal structure and the electric properties in the different temperature regions.

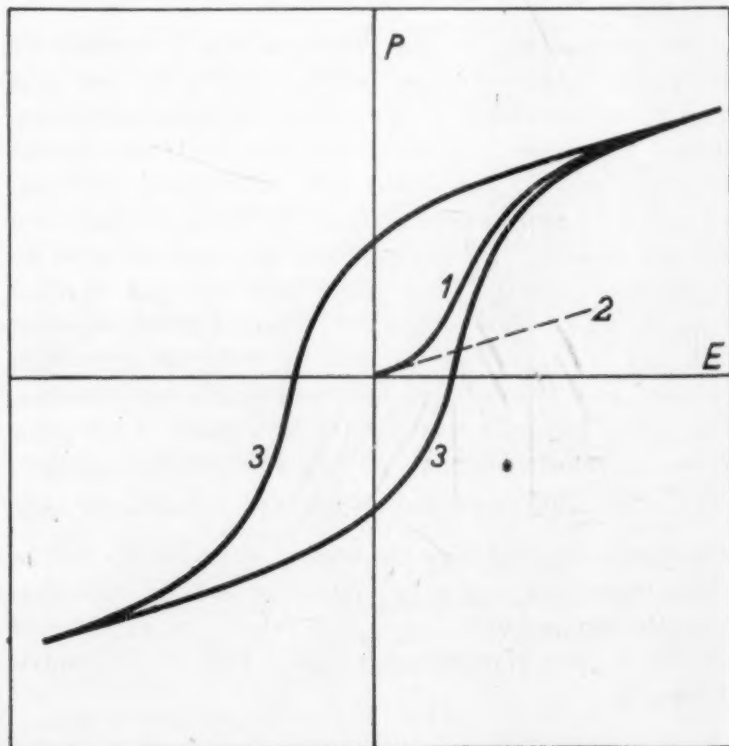*The high temperature region.* Let us consider BaTiO₃

FIG. 2. Electric polarization (P) as a function of field strength (E): 1—initial curve, 2—initial slope of initial curve, and 3—hysteresis loop.
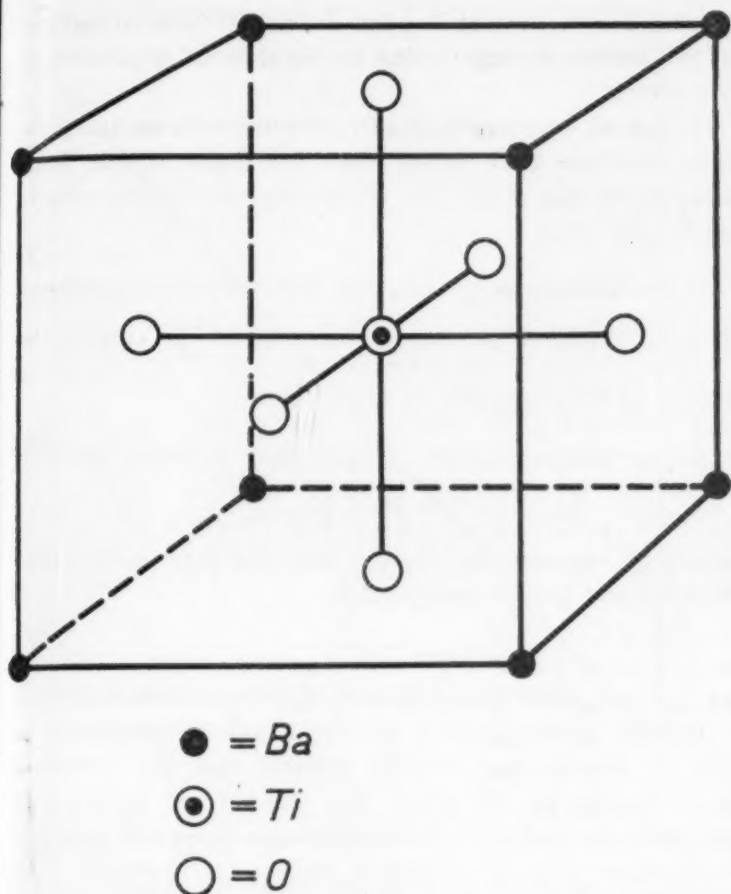
● = Ba

◉ = Ti

○ = O

FIG. 3.   Unit cell of barium titanate.

above its transition temperature. In this temperature region the substance behaves like a "normal" dielectric, except that the dielectric constant is exceptionally high and strongly dependent on temperature. Before discussing these properties we shall examine more closely the formulas giving the relation between the macroscopic dielectric constant and the properties of the component ions (or atoms).

The well-known formulas of Lorentz-Lorenz and Clausius-Mosotti become for BaTiO$_3$

$$\frac{n^2-1}{n^2+2} = \frac{4\pi}{3} N\alpha^{(e)} = \frac{4\pi}{3} N \left\{ \alpha_{Ba}^{(e)} + \alpha_{Ti}^{(e)} + 3\alpha_0^{(e)} \right\} \quad (1)$$

and

$$\frac{\varepsilon-1}{\varepsilon+2} = \frac{4\pi}{3} N \left\{ \alpha^{(e)} + \alpha^{(i)} \right\}$$

$$= \frac{4\pi}{3} N \left\{ \alpha_{Ba}^{(e)} + \alpha_{Ti}^{(e)} + 3\alpha_0^{(e)} + \alpha^{(i)} \right\}. \quad (2)$$

Here n denotes the index of refraction; N is the number of unit cells per cm^3; $\alpha_{Ba}^{(e)}$, $\alpha_{Ti}^{(e)}$, $\alpha_0^{(e)}$ are the optical polarizabilities of Ba, Ti and O ions respectively; α^i is the contribution of ionic displacement polarization.

One of the assumptions underlying eqs (1) and (2) is that the environment of every polarizable particle displays cubic symmetry, the local polarizing field then being for each particle:

$$E^{(loc)} = E + \frac{4\pi}{3} P$$

(E = electric field strength, P = polarization).

For crystals for which this symmetry condition is not fulfilled, the Lorentz-Lorenz and Clausius-Mosotti formulas must be corrected and this can be done by adding to the polarizability (9, 10) a correction term which de-

pends on the geometrical structure of the lattice and on the polarizabilities of the ions.

In the case of BaTiO$_3$ (see Fig. 3) some ions surround each other in a cubic way while others do not. For example a Ba-ion is surrounded cubically by Ba-ions (its six nearest neighbors are placed at the corners of a regular octahedron) and by Ti-ions (the eight neighbors forming a cube). For oxygen ions, however, the microscopic symmetry is not cubic (its six nearest neighbors are two Ti- and four Ba-ions). Thus for BaTiO$_3$ in eqs (1) and (2), a correction term must be added to the expression between parentheses, but we shall not use it here. In eq (1) the correction proves to be negligible.

When we try to understand the high value of the dielectric constant of BaTiO$_3$ in its cubic temperature region there appear to be at least three contributing factors. First of all BaTiO$_3$ possesses a high refractive index, namely 2.4^5; thus in eqs (1) and (2): $\frac{4\pi}{3} N\alpha^{(e)} = 0.63$, a rather high value. It is easily seen from eqs (1) and (2) that now a relatively small ionic polarization can give rise to a high dielectric constant. The cause of the high index of refraction is the compactness of the BaTiO$_2$ lattice (the Ba- and O-ions form together a close-packed cubic structure, the Ti-ions being placed in the octahedral interstices) combined with the high optical polarizability of the O- and Ba-ions. In this connection we would remark that in general the optical polarizability of oxygen ions near small, high charge positive ions appears to be much smaller than near large, low charge ions. In the case of oxygen ions next to (tetravalent) Ti-ions, however, this lowering of the polarizability of oxygen does not seem to take place. This high optical polarizability is found in many compounds containing Ti surrounded by six O-ions (TiO$_2$ in its modifications rutile [$n_\omega(D) = 2.62$, $n_\epsilon(D) = 2.90$], anatase [$n_\omega(D) = 2.56$, $n_\epsilon(D) = 2.49$] and brookite [$n_\alpha(D) = 2.59$, $n_\beta(D) = 2.59$, $n_\gamma(D) = 2.70$]; titanates with perovskite structure [CaTiO$_3$ $n = 2.38$; BaTiO$_3$ $n = 2.4^5$]; pyrophanite, MnTiO$_3$ showing ilmenite structure [$n_\omega(D) = 2.48$, $n_\epsilon(D) = 2.21$]).

In the second place a high dielectric constant for BaTiO$_3$ is favored by a large contribution from the Ti-ion to the ionic-displacement polarization. Goldschmidt (2) has remarked that the perovskite structure ABO$_3$ would be stable only if the parameter

$$t = \frac{r_A + r_O}{(r_B + r_O) \sqrt{2}}$$

were approximately unity (6). This is easily seen from Fig. 3. For $t < 1$ or $t > 1$ the ions A (e.g. Ba) or B (e.g. Ti) respectively have a relatively large space to move in; too large deviations of t from unity give rise to other structures. It appears that of all titanates, thorates, zirconates, cerates, and stannates, BaTiO$_3$ and PbTiO$_3$ occupy a singular position, since the Ti-ion can move rather easily between its six nearest oxygen neighbors. This means that at the Ti-place a considerable ionic-displacement polarizability is localized, contributing to the term $\alpha^{(i)}$ in eq (2).

A third circumstance favoring a high value of the dielectric constant is the particular structure of the

perovskites. It appears that the correction term that has to be added to the righthand side of eq (2) because of the insufficiently high symmetry of the perovskite lattice becomes considerable if at the place of the Ti-ion a polarizability is localized. Thus the "loosely bound" Ti-ion not only gives its "normal" contribution to $\alpha^{(i)}$ but also gives rise to a correction term, α_{cor}, which cannot be neglected.

If we accept the given interpretation of the high dielectric constant of $BaTiO_3$, we can easily show that a strong dependency on temperature is to be expected (7). In order to explain this dependency, the occurrence of permanent dipoles in the high temperature region has been assumed by some authors. We think, however, that such an assumption should not be made since the following simple argument can give a quantitative explanation.

Writing eq (2) with the correction term α_{cor} included as

$$\frac{\varepsilon-1}{\varepsilon+2} = \frac{4\pi}{3} N\alpha, \tag{3}$$

where α stands for $\alpha^{(e)} + \alpha^{(i)} + \alpha_{cor}$, we find for the temperature coefficient

$$\frac{1}{\varepsilon}\frac{\partial\varepsilon}{\partial T} = \frac{(\varepsilon-1)(\varepsilon+2)}{3\varepsilon}\left\{\frac{1}{N}\frac{\partial N}{\partial T} + \frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\right\}. \tag{4}$$

Putting $\frac{1}{N}\frac{\partial N}{\partial T} = -3\beta$ (β = coefficient of linear expansion) and approximating $\varepsilon-1$ and $\varepsilon+2$ by ε, we obtain from eq (4):

$$\frac{1}{\varepsilon}\frac{\partial\varepsilon}{\partial T} = \varepsilon\left\{-\beta + \frac{1}{3}\frac{1}{\alpha}\frac{\partial\alpha}{\partial T}\right\}, \tag{5}$$

or $\varepsilon = \dfrac{1}{\left(\left(\beta - \dfrac{1}{3}\dfrac{1}{\alpha}\dfrac{\partial\alpha}{\partial T}\right)(T-T_0)\right)}, \tag{6}$

where T_0 is an integration constant.

We have already seen that experiments above the transition temperature θ can be described by

$$\varepsilon = \frac{1}{\beta(T-\theta)} \tag{7}$$

From this it follows that

$$\frac{\partial\alpha}{\partial T} = 0, \tag{8}$$

and

$$T_0 = \theta. \tag{9}$$

The value of θ can be expressed in terms of the dielectric constant ε' measured at a temperature T' by

$$\theta = T' - \frac{1}{\beta(\varepsilon'+2)} \tag{10}$$

It is to be noted that to eq (7) a factor must be added in order to correct for the porosity of the titanate samples. If we call ε_{exp} the measured value of the dielectric constant of a sample with a small amount p of spherical holes, eq (7) becomes

$$\varepsilon_{exp} = \frac{1 - \frac{3}{2}p}{\beta(T-\theta)}. \tag{7'}$$

As to eq (8), one might think that this equation is rather trivial. It is necessary, however, to discuss separately the temperature dependency of all three contributions to $\alpha = \alpha^{(e)} + \alpha^{(i)} + \alpha_{cor}$. It is well known that $\alpha^{(i)}$ increases with increasing temperature, since the re-

storing forces playing a part in the infrared vibrations of the lattice decrease owing to the thermal expansion of the crystal.

It can be expected that $\alpha^{(e)}$ also depends on temperature since we have found that for many simple ionic compounds like NaCl $\alpha^{(e)}$ shows a positive temperature coefficient (8).

It is difficult to predict the temperature dependency of α_{cor}. From eq (8) we can infer that $\frac{\partial\alpha_{cor}}{\partial T}$ cancels the effects of $\frac{\partial\alpha^{(e)}}{\partial T}$ and $\frac{\partial\alpha^{(i)}}{\partial T}$.

It is interesting to notice the analogy between

$$\chi_{el} = \frac{\varepsilon-1}{4\pi} \approx \frac{\varepsilon}{4\pi} = \frac{1}{4\pi\beta(T-\theta)}, \tag{11}$$

where χ_{el} denotes the electric susceptibility, and Curie-Weiss's law for paramagnetics

$$\chi_{magn} = \frac{C}{T-\theta_m}. \tag{12}$$

(χ_{magn} = magnetic susceptibility, θ_m = Curie temperature).

It must be emphasized, however, that the similarity is only a formal one. In the electric case χ_{el} increases with decreasing T, since the number of polarizable particles per unit of volume increases (thermal contraction effect); in the magnetic case χ_{magn} increases with decreasing T, since the permanent magnetic moments can be more easily oriented (Boltzmann-factor effect).

All these considerations about polarizabilities and temperature-dependencies hold equally for mixed crystals of $BaTiO_3$ with other perovskites. Eq (10) enables us to explain the variation of the peak temperature θ with the composition of the mixed crystals. By substitution, by means of the corrected Clausius-Mosotti formula, we find

$$\theta = T' - \frac{1}{3\beta} + \frac{4\pi}{9\beta}N'\alpha', \tag{10'}$$

where N' and α' are the values of N and α at the temperature T'.

Since all the variables in this formula show only a small and (to a first approximation) linear dependency on the composition, we see at once that θ also varies linearly (Fig. 4). The variations of the product $N'\alpha'$ when replacing Ba by Sr are only small; because of the factor $\frac{1}{\beta}$, however, large effects on θ result.

The low temperature region. Let us consider a titanate dielectric below its transition point, and thus in the temperature region where spontaneous polarization occurs. In view of crystallographic considerations it is reasonable to ascribe this polarization mainly to a displacement of the Ti-ions from the centers of their octahedral interstices. Such an eccentric Ti-ion acts on its environment as if a Ti-ion were placed in the center, together with a dipole of moment equal to ionic charge × displacement. It is interesting to examine the interaction of such dipoles more closely. The Ti-ions are placed at the points of a simple cubic lattice; thus it is evident that the state of lowest energy should be a macroscopically unpolarized arrangement where alternating strings of dipoles occur, rather than a polarized arrangement where all dipoles are pointing in the same
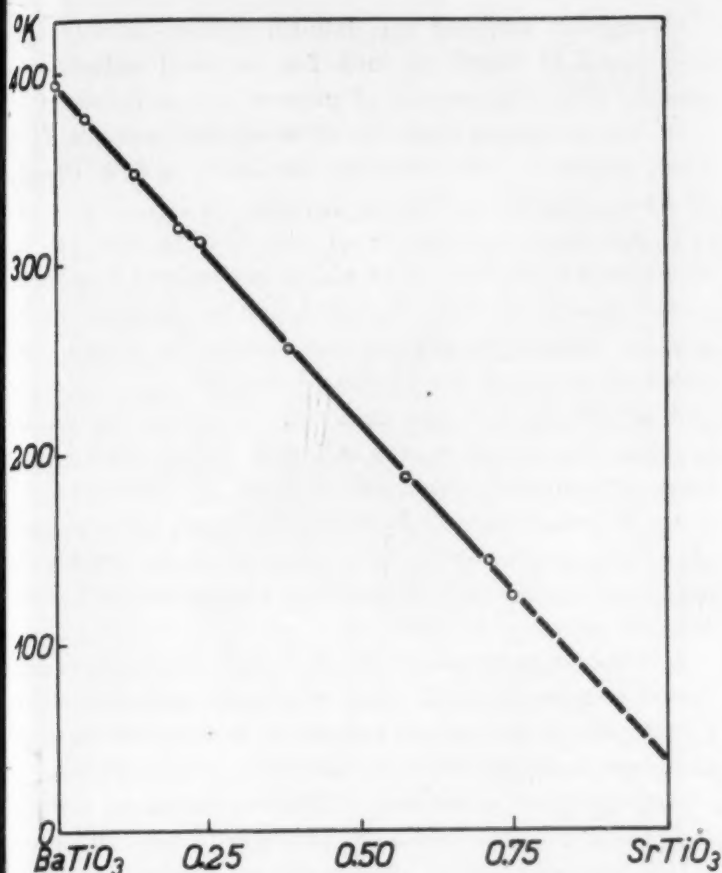
FIG. 4. Transition points of mixed crystals of barium and strontium titanate.

direction (5). It is possible, however, to understand why in the perovskite lattice the polarized state is favored. Let us consider a cross section through the lattice (Fig. 5). All Ti-ions are separated by easily polarizable O-ions, in which dipole moments can be induced by the Ti-dipoles. It is easily seen that a parallel orientation of a row of Ti-dipoles is favored by the oxygen ions A, which assume induced moments in the same direction. Such rows of parallel Ti-dipoles are coupled together by oxygen ions B, the moments in these oxygen ions pointing in the opposite direction. For other positions of the oxygen ions B such a coupling
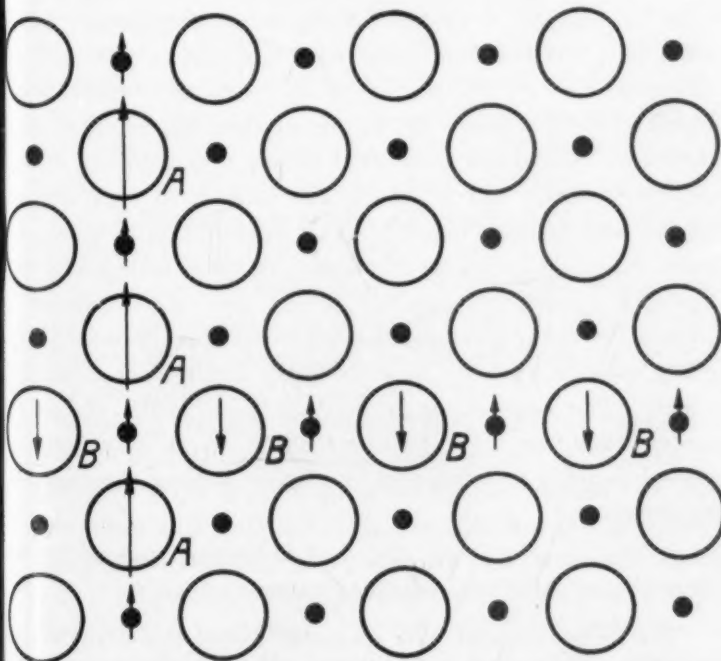

FIG. 5. Cross-section through the barium titanate lattice.

would not occur.[1] The particular properties of the perovskite structure making the spontaneous polarization possible also give rise to a favorable deviation from the formula of Clausius-Mosotti in the temperature region above θ. The infrared vibrations corresponding to tetragonal deformation have a small restoring force and give a large contribution to the ionic polarizability and thus to ε.

The transition temperature. Coming from high temperatures, the cubic form of $BaTiO_3$ becomes at a certain temperature unstable with respect to the polarized tetragonal form (3) (probably a first-order transition). There are two approaches to describing this transition, coming from the high and from the low temperature region.

In the first place it is to be noted that the restoring force just mentioned contains, besides positive contributions (e.g., the Born repulsion), negative contributions arising from the polarization of the lattice during the vibration. In view of the close relation between this polarization and ε, the negative contribution to the restoring force becomes increasingly important as ε increases by the contraction of the lattice, so that at a certain temperature the negative prevails over the positive contribution, and as the corresponding frequency approaches zero, a spontaneous deformation of the lattice occurs. At the same moment the dipoles, which play such an important role in the low temperature region, are formed by a shift of the titanium ions in the direction of the elongated c-axis.

On the other hand, we can start from the spontaneously polarized state. In the section on the low temperature region it was made plausible that the interaction between the Ti-dipoles takes place through the medium of the oxygen ions between them. Such an interaction must decrease as the lattice expands, so that at a certain temperature the energy of interaction becomes of the order of kT and the spontaneous polarization is destroyed.

It is difficult at the moment, however, to treat these problems quantitatively, since data concerning internal forces are rather scarce and particularly because the ionic picture used is only a zero-order approximation.

References

1. EVANS, H. T., JR. and BURBANK, R. D.   *J. chem. Phys.*, 1948, **16**, 634.
2. GOLDSCHMIDT, V. M., quoted by A. HOFFMANN.   *Z. Physik. Chem. B.*, 1934, **28**, 65.
3. HARWOOD, M. G., POPPER, P., and RUSHMAN, D. F.   *Nature*, Lond., 1947, **160**, 58.
4. HIPPEL, A. VON, *et al.*   *Ind. eng. Chem.*, 1946, **38**, 1097.
5. LUTTINGER, J. M. and TISZA, L.   *Phys. Rev.*, 1946, **70**, 954.
6. MEGAW, H. D.   *Proc. phys. Soc.*, 1946, **58**, 133.
7. SANTEN, J. H. VAN and JONKER, G. H.   *Nature*, Lond., **159**, 333–4.
8. ——.   *Philips Res. Rep.*, 1948, **3**, 371.
9. SANTEN, J. H. VAN and OPECHOWSKI, W.   *Physica's Grav.*, 1948, **14**, 545.
10. SKANAVI, G. J.   *Acad. Sci. U.S.S.R.*, 1948, **59**, 231–4.

[1] In the structure of the hexagonal form of $BaTiO_3$ proposed by Evans and Burbank (1), which shows a low dielectric constant, such an effect cannot occur, the rows of Ti-ions being interrupted.

Comments and Communications

Late Pleistocene Dates Derived from Radiocarbon Assays

Current research on natural radiocarbon (LIBBY, W. F., *et al. Science*, 1949, 109, 227) presents an opportunity to learn the actual dates of origin of carbon-bearing material less than about 35,000 years old. Such material includes, among other substances, buried soils, wood, charcoal, bone, and calcareous shells.

If adequate amounts of this material are collected from horizons of accurately known stratigraphic position and are assayed, the dates of these horizons (if less than about 35,000 years old) can be determined. The importance of such dating for establishing the chronology of the later part of the Wisconsin age of the Pleistocene epoch is obvious.

In particular, if the Mankato drift can be dated by this method, rough dates can be obtained for earlier Pleistocene glacial stages. Kay's estimates of the dates of earlier Pleistocene drift sheets were obtained by comparing the depth of chemical decomposition of each of these drifts with the decomposition of the Mankato drift, for which an age of 25,000 years was assumed (cf. FLINT, *Glacial geology and the Pleistocene epoch*, 1947, p. 399). The application of radiocarbon assay to the Mankato drift should improve Kay's estimates materially.

This research on natural radiocarbon is being conducted at the Institute for Nuclear Studies, University of Chicago, under the direction of W. F. Libby. Assays of carbon-bearing material can be made there promptly, if the material has great enough stratigraphic importance.

For the present, material for assay is being selected in collaboration with the Committee on Radioactive Carbon 14, appointed by the American Anthropological Association, under the chairmanship of Frederick Johnson. The writer is serving on the Committee as member for geology. A number of projects, involving dates that are especially desired, have been set up. Those having primary significance for anthropology are named Early Man, Peru, Central and Northern Mexico, Mesopotamia and Western Asia, Scandinavia and Western Europe, Yukon-Alaska, California-Oregon, Hopewell-Adena, and Southeastern United States. In some of these projects the dating of archaeological material will also have direct significance for Pleistocene geology.

Geologic material suitable for assay is less abundant and less intensively collected than archaeological material. The committee believes, however, that when geologists having access to such material are acquainted with the general problem and with sampling requirements in particular, they will very quickly supply samples of geological importance.

Geologists working on late-Pleistocene stratigraphy are therefore urged to look for material suitable for assay. The requirements at present are as follows:

1. The minimum quantity of wood for assay is $1\frac{1}{2}$ lb (dry weight). The minimum for shells is 4 lb because of their smaller content of carbon.

2. An exact description of the locality and of the stratigraphic horizon from which the collection is made should be sent with the material, and the basis of stratigraphic dating of the horizon should be stated. Detailed photographs would also be helpful.

3. Evidence that the material is indigenous to the horizon from which it was collected, rather than having been derived from some older horizon, is important.

4. Materials derived from two different horizons, each of known stratigraphic date superposed in vertical sequence, are especially desired for the purpose of checking the accuracy of assay.

5. Two or more pieces of material composed of different substances (e.g., wood and bone), collected at different points in a single horizon of known stratigraphic date, are also especially desired for assay checking.

Any geologist possessing or having access to material that meets these requirements is urged to send the writer a full description of it. Please do not send the material.

RICHARD FOSTER FLINT

Department of Geology, Yale University

A Note on Inexpensive One-Way Vision Material

Many psychologists are interested in effective but inexpensive means of assuring one-way vision for observation. The new commercial one-way vision mirror glass is far more effective and less streaky than earlier half-silvered mirrors, but remains very expensive. White-painted screening, while cheap, is not totally effective in barring vision into the observation room or booth.

Some time ago the use of colored cellophane for this purpose was suggested (PRATT, J. G., *Amer. J. Psychol.*, 1937, 49, 309). While this note was in press a similar one was described: (GRUMMON, D. L. *Amer. Psychologist*, 1949, 4, 114). However, in our experience, when enough layers of cellophane were used to bar vision in the wrong direction vision out of the booth tended to be obscured to an undesirable degree. For several years now, we have successfully used uncolored, silvered cellophane for one-way vision material.[1] In our use, the material is placed on the observation room side of a double plate-glass window opening on a brightly lighted experimental room. The cellophane is held in place with strips of scotch tape, so that the observation room may be converted rapidly to a camera booth for filming through the window.

LAWRENCE JOSEPH STONE

Department of Child Study, Vassar College

[1] We have obtained this material under the trade name "Hy-Siltone" in 50-ft rolls, 20-in. wide, for $2.50 from the Hy-Sil Manufacturing Company, Revere, Mass.

Book Reviews

George Ellett Coghill: naturalist and philosopher. C. Judson Herrick. Chicago: Univ. Chicago Press, 1949. Pp. xi + 280. $5.00.

In the small book which first made Coghill internationally known, *Anatomy and the problem of behaviour* (Cambridge, Engl.: 1929), Coghill wrote in the preface that in Judson Herrick "I have enjoyed these many years a constant influence of orientation and stimulation in neurological work." The living friendship between the two men lasted almost half a century. In the nature of their special scientific work, and in the breadth of their scientific and philosophical interests, Herrick and Coghill not only were very similar, but helped each other to arrive at this similarity. Nothing, then, could be more appropriate than that. Herrick should write the story of Coghill's life and work and its significance.

It may at once be said that this is an extraordinarily good book. It should be read by the whole scientific confraternity, especially by those younger men who are about to enter its not untroubled domain. And if only the lay public could be persuaded to read this book, about the life, work, and vicissitudes of a great representative American man of science, it would be much to the advantage of society in general and to the scientist in particular.

Herrick makes the story of the life of science as lived by Coghill, the development of his science, and the interrelationship of the two themes, the vehicle for a most cogently expressed plea for the humanization of science. "My thesis," writes Herrick in his preface, "is this: The traditional code of science—that is, the objectives sought and the methods of investigation—cannot satisfy the requirements of our critical times, and this is why science has failed to measure up to the opportunities and obligations before it. The generally accepted ideas of what natural science is and what it is for are out of date and need radical revision. We have been taught for centuries that pure science is a system of facts and impersonal abstractions, devoid of human interest and without concern for values. It isn't, and it cannot be. The time has come to recognize the humanistic value of science—so-called pure science, I mean—and to adjust our practice accordingly."

And again, in the epilogue: "Scientific facts are not worth what it costs to discover them unless they can be so interpreted as to lead to value-judgments as guides to more satisfying purposeful action."

This book is one of the best proofs of this thesis.

The book is divided into three parts. The first is devoted to the life of Coghill living his science. Scientists will read this chapter with admiration, and perhaps not altogether with astonishment at the academic disaster which was so unjustly and so cruelly visited upon Coghill. The second part contains the best and most readable account of Coghill's important work and its significance that has thus far appeared. The third part is devoted

to an invaluable discussion—in dialogue form—of Coghill's philosophical outlook. Five appendices are devoted to notes, a list of published works and manuscripts, supplementary biographical data, data on the killfish, and acknowledgments. There is a good index.

This is a great book on one great American man of science by another.

M. F. Ashley Montagu

Hahnemann Medical College

Science at war. J. G. Crowther and R. Whiddington. New York 16: Philosophical Library, 1948. Pp. iv + 185. (Illustrated.) $6.00.

The output of books on the late war has only begun. A large number of purely factual reports have come out, written to give the general public an idea of what went on. But the controversial books, written in an attempt to draw lessons or conclusions from the conflict, are just beginning. Blackett's *Fear, war and the bomb* is one and Fuller's *History of World War II* is another, less disagreed with than the former, though nearly as thought-provoking.

Science at war is one of the factual reports, this time about the contributions of British scientists to the war effort, particularly in radar, operations research, nuclear physics, and undersea warfare. It is a counterpart to the Little, Brown series on *Science in World War II*, which treats of the American contribution; and a comparison of the English book with the American series, particularly with J. P. Baxter's *Scientists against time*, is enlightening.

One notices that the British book is more concerned with the scientific ideas and factual content involved in the developments, whereas the American effort spends more time on questions of organization and personal aspects. Baxter's book is easier to read, but if one is persistent one will gain more understanding of the working principles of radar and of asdic, for instance, from Crowther and Whiddington. In particular, their section on radar, with its many clarifying pictures, is well worth careful reading.

Reading both books produces some confusion at first, for they are, to some extent, mutually exclusive. To read *Science at war* gives one the impression that 90 percent of the contribution was made in England, whereas Baxter's book gives the impression that 75 percent was done over here. This semichauvinism is understandable, of course, for each author's task was to report the contributions of his own country's scientists and he could not do this by spending much time on (to him) foreign developments. One only hopes that, sometime, a complete history will be written, placing all contributions in their proper relation.

Of particular interest is the section on operational research, since this aspect of science's contribution was

so inadequately covered in the American series. Crowther and Whiddington give an interesting, though somewhat fragmentary, discussion of early developments, and a very clear presentation of the scope and methods of this new branch of applied science. A number of examples of the application of the methods are given, then a discussion of general principles which is adequate, though not as complete or satisfactory as the famous articles of Blackett and of Goodeve.

The discussion on the atomic bomb adds nothing beyond what is contained in the Smyth report, other than a bit more detail of the British contributors and their early activities before coming to the United States to work for the Manhattan District.

The chapter on ''Science and the Sea,'' on the other hand, contains much on mines and minesweeping that is not to be found in American books. This is, of course, owing to the fact that our forces had very little trouble with mines, whereas the British suffered considerable loss, especially because of the magnetic mine, which they had solved and countered before our entry into the war. The discussion of submarine detection is brief, but fairly complete.

On the whole, this book is a readable and interesting volume, a useful complement to our own reviews.

PHILIP M. MORSE

Massachusetts Institute of Technology

Blood transfusion. Elmer L. DeGowin, Robert C. Hardin, and John B. Alsever. Philadelphia-London: W. B. Saunders, 1949. Pp. xii + 587. (Illustrated.) $9.00.

A valuable if expensive lesson from the recent World War was the important uses of blood, plasma, and plasma derivatives in the specific therapy of many conditions previously treated only symptomatically if at all. The very low mortality in the members of the armed forces in this war has been credited in part to the free use of these materials. When the many experienced physicians returned from military service to civilian practice, they demanded more blood and blood fractions for everyday surgery, emergency medicine, and replacement therapy. This has lead to a considerable increase in blood banks and a great demand for many more.

To answer the many questions which the physician asks regarding blood transfusion, there has been an unusual paucity of authoritative and up-to-date text books. The appearance of *Blood transfusion* by DeGowin, Hardin and Alsever can justifiably be acclaimed as the answer to many a physician's prayer and a standard source of information which should help the everyday practitioner, the beginner in blood bank work, and the experienced director of such an operation who encounters problems of management.

It is well to know the authoritative background for this book. Elmer L. DeGowin has been, for almost ten years, the director of a large blood transfusion service and has served as a member of the important Committee on Blood and Blood Derivatives of the National Research Council. Robert C. Hardin was senior consultant in blood transfusion in the European Theatre of Operations and in

charge of the European Theatre of Operations Blood Bank in Paris. John B. Alsever had considerable experience as director of the Blood Plasma and Blood Donor Services for the Office of Civilian Defense and the American National Red Cross during the war.

Such a wealth of personal experience cannot help but yield valuable information on blood transfusion, blood bank management and allied problems. In addition, the authors have reviewed the literature comprehensively and bring a widely scattered bibliography up to date.

If any criticism of this much-needed text is possible, it is that recent advances in this field are continuing so rapidly that already new techniques and new therapeutic possibilities not described here are being exploited. The chapter on the use of blood derivatives, one of the most challenging advances in medicine, is too brief in view of these recognized future possibilities.

It is hoped that this volume will be as widely read as it needs and deserves to be and that new editions will keep the book in its present position of absolute leadership in this field.

LOUIS K. DIAMOND

Children's Hospital,
Boston, Massachusetts

Contribution a l'Etude de la Structure Moléculaire. (Volume Commemoratif Victor Henri.) With prefaces by L. Brillouin and J. Duchesne. Liège, Belgium: Maison Desoer, 1947–1948. Pp. xiii + 314. (Illustrated.)

Victor Henri will long be remembered for his significant contribution to the experimental work in molecular spectroscopy. His death, while he was working as a physicist in the service of his country, came at a time when there was little time to pause and pay respect to his memory. His former students and colleagues resolved, however, when times again became more normal, to memorialize his contribution with a volume of works in the field where he had served as so great a stimulation. This volume of papers is entitled *Contribution to the study of molecular structure* and contains 26 contributions by 36 authors, in addition to two prefaces by L. Brillouin and J. Duchesne.

It is not possible in a review of this nature to comment critically on a compilation of so great a diversity. One cannot avoid, however, observing that the list of authors is studded with stars from the field of molecular structure and molecular spectroscopy. Some of the authors are physicists, some are chemists; some are experimenters and some are theoretical scientists; but all are well known in an international sense.

The volume represents a compilation that every student of the structure of molecules will want to possess and will want to refer to again and again in his more creative work for many years to come. It should, therefore, admirably serve its purpose, namely, to keep the name of Victor Henri alive among the men who serve where he left off.

HARALD H. NIELSEN

Mendenhall Laboratory of Physics,
Ohio State University

NEWS

and Notes

Karl T. Compton has been elected director of the McGraw-Hill Publishing Company. Dr. Compton is chairman of the Research and Development Board of the National Military Establishment and chairman of the Corporation of the Massachusetts Institute of Technology.

H. B. Mann, professor of mathematics at Ohio State University, has been appointed visiting professor at the University of California for the academic year 1949–50. Dr. Mann, who recently took several months' leave to head a project at the Applied Mathematics Laboratories of the National Bureau of Standards, has returned to Ohio for the summer quarter.

Allen Goodrich Shenstone, of Princeton University, has been appointed acting chairman of the Department of Physics in the absence of Henry de Wolf Smyth, who is on leave as a member of the Atomic Energy Commission.

Albert Claude, associate member of the Rockefeller Institute, has been appointed professor at the University of Brussels, and director of the Institut Jules Bordet.

Nelson Marshall, director of the Virginia Fisheries Laboratory, has been appointed dean of the College of William and Mary. He will continue to serve in the laboratory, which is an associated organization of the college.

Wallace R. Brode, associate director of the National Bureau of Standards, has been appointed a member of the Board of Governors of the American Institute of Physics to replace the late **A. H. Pfund** of Johns Hopkins University. Dr. Brode will represent the Optical Society of America; he is a member of the Society's Board of Directors and associate editor of its journal.

Julius S. Youngner, formerly of the National Cancer Institute has been appointed assistant research professor of bacteriology at the University of Pittsburgh's School of Medicine.

John C. Warner, head of the chemistry department of the Carnegie Institute of Technology, has been named president-elect to succeed **Robert E. Doherty,** who will retire on July 1.

Visitors

Recent visitors at the National Bureau of Standards were: **Hadji Argyris,** head of the aircraft structures research group of the Royal Aeronautical Society of Great Britain; **G. McAlpine,** engineer with Kelvin Bottomley and Baird, of England; **A. Strasheim,** head of the Spectrochemical Section, National Physical Laboratory, Union of South Africa; **André Houpeurt,** chief of the Production Laboratory, French Institute of Petroleum, Paris; **Edy Velander,** director of the Royal Swedish Academy of Engineering Sciences, Stockholm.

N. Kurti, physicist of Oxford University, England, will take part in the Symposium on Modern Physics to be held at Oak Ridge, August 22–September 2.

Grants and Awards

The Charles Goodyear Medal for outstanding achievement in rubber chemistry was awarded to Harry L. Fisher, director of organic research of U. S. Industrial Chemicals, Inc., at the May 24 meeting of the American Chemical Society's Rubber Division, in Boston.

The first **Lester N. Hofheimer Research Award** of fifteen hundred dollars was given to Benjamin Pasamanick, head of the Children's Service, Division of Psychiatry, Kings County Hospital, Brooklyn, New York, at the recent convention of the American Psychiatric Association. The award is offered to the psychiatrist under 40 years of age who has published the best research in the preceding three years. Dr. Hofheimer's paper ''A Comparative

Study of Behavioral Development of Negro Infants'' appeared in the *Journal of Genetic Psychology,* 1946, Vol. 69.

Ward Harrison, retired director of the Engineering Division of General Electric Lamp Department, has been awarded the 1949 **I. E. S. Gold Medal** by the Illuminating Engineering Society for his contributions to all phases of illumination development. The award will be presented at the I. E. S. National Technical Conference to be held at French Lick, Indiana during the week of September 19.

H. Trendley Dean, director of the National Institute of Dental Research, will receive the **Gorgas Award** for outstanding contributions in the field of military medicine. It will be presented November 11 at the annual banquet of the Association of Military Surgeons of the United States, which selected Dr. Dean for the award.

Recipients of the first **Medical Library Association scholarships,** from funds granted by the Rockefeller Foundation are: Lydia Pazos Pérez, assistant to the director of the Library of the Faculty of Medicine, University of Havana; María Alicia Izquierdo Guzman, assistant in the Library of the Faculty of Medicine, University of Chile; and María José Lessa da Fonseca, librarian of the Faculty of Medicine, University of São Paulo, Brazil.

Fifteen winners of the 1949 **Indiana Science Talent Search** were given memberships in the AAAS by Walter Leckrone, editor of the *Indianapolis Times.* The awards were presented by the chairman of the Talent Search Committee, R. W. Lefler, Department of Physics, Purdue University.

Alfred P. Sloan, Jr., has given one million dollars to the **Massachusetts Institute of Technology** for its new metals-processing laboratory. The laboratory is to be named for Mr. Sloan.

Eli Lilly and Company of Indianapolis has awarded nine thousand dollars to John C. Krantz, Jr., professor of pharmacology, University

of Maryland School of Medicine, for research on the action of drugs useful in the treatment of hypertension and cardiovascular diseases.

Howard E. Fritz, vice president of the B. F. Goodrich Company in charge of research, was named 1949 winner of the **Lamme Medal of Ohio State University,** on June 10. Dr. Fritz was cited for his development of Koroseal and rubber products for use in chemical engineering industries.

Colleges and Universities

Rhode Island State College, with the cooperation of the Woods Hole Oceanographic Institution, has established a graduate student training program in biological oceanography and marine fisheries biology. Instruction and supervision of research will be provided by members of the staffs of the two institutions, with emphasis placed on open ocean investigation. Arrangements are being made for a limited number of students who will enroll as candidates for the M.S. degree in marine biology. The first year will be spent in Kingston and at the Narragansett Marine Laboratory; the second year at Woods Hole. Those qualified for basic oceanographic research will occupy quarters provided for them in the Woods Hole Oceanographic Institution, and those preparing for a career in applied fisheries biology may be assigned to the U. S. Fish and Wildlife station. The program is under the general supervision of Charles J. Fish and applications should be addressed to the Director of Admissions, Rhode Island State College, Kingston, R. I. Candidates for this curriculum may also make application for a fellowship. There are five available at the rate of $1,500 per year.

Meetings and Elections

Computers. More than two hundred people assembled at Oak Ridge last April to attend a meeting of the Association for Computing Machinery. The program was devoted primarily to an assessment and evaluation of large scale computing machinery as a scientific tool, and to discussions of the hazards that beset the unwary user. But there were side attractions too, such as a visit to the American Museum of Atomic Energy, now permanently installed in Oak Ridge, and a demonstration of the IBM Corporation's new model 604 multiplier.

The demand for high speed automatic machinery becomes increasingly great in all phases of science and technology, nuclear science along with the rest. In atomic energy laboratories, IBM installations are standard equipment for scientific computing. Considerable use is being made of the ENIAC, the SSEC, and Harvard's Mark I, and some of the improved versions now under development will no doubt be acquired. This was the motivation for holding the meeting in one of the principal centers of atomic research. There were, however, other organizations interested in the use or development of these machines represented on the program and among the attendance.

The National Bureau of Standards had the largest representation on the program with a total of six papers. Some papers dealt with computational techniques for large scale calculations and the special difficulties that arise therein and some dealt with problems of design. At least five of the papers represented work done, in whole or in part, for the armed forces, not to mention the banquet speech by Nina Rees, of the Office of Naval Research, on "The Forgotten Man of Computing." A brief report on developments in Australia was given by T. G. Room, of the University of Sydney.

Besides the classical problems of solving complicated equations and systems of equations, two more recent computational techniques were discussed. One is an application of the theory of games; the other is the use of stochastic methods, or what is now called the Monte Carlo Technique. Of these, the former has importance for the military, the latter is much used in atomic energy research. Both are distinctly techniques for large scale computing.

Although most of the program was devoted to digital machines, two papers dealt with machines of the analogy type. One was by S. H. Caldwell, on the differential analyzer; the other by Ray Pepinsky, whose machine for use in crystal analysis has received much acclaim since its recent completion.

Special efforts were made by the Oak Ridge Institute of Nuclear Studies, one of the sponsors of the meetings, to bring out interested research workers from the academic institutions of the Southeast. This was thought desirable because as more machines become available their use in academic research will spread.

Besides the Institute, the other sponsors of the meetings were Oak Ridge National Laboratory, Carbide and Carbon Chemicals Corporation, and Fairchild Corporation, NEPA Division.

A. S. HOUSEHOLDER

A symposium on modern physics will be held at Oak Ridge August 22–September 2, under the sponsorship of the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies. The 32 lectures to be given will include such topics as the current status of meson theory, the new quantum electrodynamics, recent progress in low temperature physics, declassified nuclear reactor theory, and classical nuclear physics. The lecture staff will be composed of physicists who are spending the summer at the laboratory—among them S. M. Dancoff, University of Illinois; J. C. Daunt, Ohio State University; Eugene Feenberg, Washington University; Hubert M. James, University of Illinois; and Alvin M. Weinberg, Oak Ridge National Laboratory.

The American Mathematical Society will hold its 55th summer meeting at the University of Colorado, Boulder, August, 30–September 2, in conjunction with the summer meetings of the **Econometric Society,** the **Institute of Mathematical Statistics,** and the **Mathematical Association of America.** The 31st colloquium, on topological dynamics, will be presented by G. A. Hedlund, of Yale University.

The Second International Biometric Conference will be held at the University of Geneva in Switzerland on August 30–September 2,

under the sponsorship of the Biometric Society. Aspects of biometry which will be considered in the scientific sessions include recent applications in genetics, teaching and education, experimental design, the present status of the science, industrial applications and biological assay. The conferences will close with a session of contributed papers. Further information and reservations are obtainable through the Secretary of the Conference Committee, Professor Arthur Linder, 24 Avenue de Champel, Geneva, Switzerland.

The First International Congress of Civil Engineering was held in Mexico City April 30–May 7, at the invitation of the Colégio de Ingenieros Civiles de México. Approximately 800 civil engineers were in attendance—nearly 200 from outside Mexico, with 24 countries represented. The technical program included some 175 papers dealing with all aspects of civil engineering, with particular emphasis on practice throughout the Latin American countries. Technical works visited on inspection trips during the week included the Lerma River water supply project of Mexico City, Valsequillo Dam in the State of Puebla, and the Tecamachalco Experimental Laboratory of the Department of Hydraulic Resources. Following the congress, there were trips for a number of the delegates to civil engineering works of interest at more distant points. It is planned that the Second International Congress of Civil Engineering will be held in 1953 at a location to be determined later, possibly Brazil or Puerto Rico.

Industrial Research Institute, Inc., New York City, elected the following officers at its annual meeting May 23–25: J. H. Schaefer, Ethyl Corporation, president; C. F. Rassweiler, Johns-Manville Corporation, vice president. C. G. Worthington was reappointed secretary-treasurer.

Lewis L. Strauss, member of the U. S. Atomic Energy Commission, was elected president of the **Corporation of the Institute for Advanced Study,** Princeton, New Jersey at its

recent annual meeting. Herbert H. Maass of New York, who had been both president and chairman of the board, was reelected chairman of the board.

The Latin American Unesco Field Science Cooperation Office, following the suggestion of the Latin American Conference of Scientific Experts held in Montevideo in September, 1948, is collecting for publication biographical and technical data on scientists and scientific institutions and societies.

All Latin American scientists and scientific organizations are invited to send any possible information on their activities to Centro de Cooperación Científica para América Latina de la Unesco, Agraciada 1875, Montevideo.

The New York Zoological Society has just placed on exhibition a collection of rare birds and mammals captured by its Belgian Congo Expedition, which returned June 15. Charles and Emy Cordier, animal collectors for the society, spent over a year and a half assembling the two hundred specimens, which include a baby mountain gorilla, an okapi, Congo peacocks, black guinea fowl, giant pangolins, aardvarks, at least seven kinds of monkeys, elephant shrews, a finfoot, and sunbirds.

One of the most difficult problems facing the Cordiers on their return was that of providing a substitute diet for the animals. Giant pangolins and aardvarks feed on termites; elephant shrews subsist on a diet of grasshoppers. Mr. Cordier has accustomed these mammals to a diet including raw meat, eggs, and milk. Sweet potato leaves, customary food for the Colobus monkeys and antelopes, have been supplied to the Bronx Zoo by the A and P grocery chain.

The Australian Council for Scientific and Industrial Research, a body responsible to the federal government through a cabinet minister, has recently been reconstituted as the Commonwealth Scientific and Industrial Research Organization. The change in name is accompanied by some changes in administration, concurrently with the election of a

new executive body. This body of the C.S.I.R.O. has now assumed greater responsibility, although the full council still functions in an advisory capacity to the executive. The Australian Commonwealth government announced on May 18 that the new executive would consist of the following: chairman, Ian Clunies Ross; chief executive officer, F. W. G. White; both former members of the executive of C.S.I.R. The appointments will be for seven years. They succeed respectively Sir David Rivett, F.R.S., who will however, remain associated with the new organization as chairman of the advisory council, and A. E. V. Richardson, whose ill health has necessitated his retirement. The third full time executive member will be S. H. Bastow, formerly chief of the Division of Tribophysics, C.S.I.R., appointed for five years. The fourth member will be D. A. Mountjoy whose three year term expires next November. H. J. Goodes, assistant secretary, Commonwealth Treasury, has been appointed for three years to the fifth seat on the executive.

The reason for reconstitution of the council is the desire of its members, and Australian scientists generally, to avoid restrictions in carrying out fundamental scientific research devoted to the development of Australian resources and industries. During the war, responsibility for a considerable amount of both fundamental and applied research for supply departments and the armed forces devolved upon the C.S.I.R., but it is the wish of the government and of scientists in Australia that complete freedom be retained, as far as possible, for postwar research in nonmilitary matters, which are rightly the concern of C.S.I.R.O. Consequently, research work of a nature which should be restricted because of its importance to national defense is now to be carried out by the Department of Supply and Development, which has assumed the responsibility for the administration of the Division of Aeronautics (formerly a division of C.S.I.R.), Defense Research Laboratories (formerly Munitions Supply Laboratories), and the Long Range Weapons project.

A four-year survey of the sky will begin July 1 at Palomar Observatory, under the joint sponsorship of the National Geographic Society and the California Institute of Technology. The aim of the project is to provide a comprehensive sky atlas, for use primarily in selecting areas and objects for intensive study with more powerful telescopes.

Palomar's 48-inch Schmidt telescope, which will be used for the photomapping, has already been in operation for two or three years, piling up work for the observatory's new 200-inch telescope. The Schmidt's wide angle lens, which can focus on a single 14×14-inch plate a swathe of sky equal to a dozen diameters of our moon, will scan the sky in broad quadrangles. Identical exposures through blue and red filters will be made for each area. Palomar astronomers expect to obtain no more than four pairs of matching red and blue plates in a single night, even under ideal weather conditions. A blue exposure takes 30 minutes; a red, about an hour.

Three-fourths of the heavens can be reached from Palomar with high accuracy; an additional ten percent can be covered in some degree. A supplementary survey of the remainder will be made after the four-year study is completed. The Palomar survey will record some five hundred million stars and perhaps ten million complete stellar systems of extragalactic nebulae. The resultant sky atlas, equivalent in size to 20 large volumes, will comprise reproductions of more than 2,000 overlapping plates.

The Schmidt telescope, invented in 1930 by Bernhard Schmidt, was the most significant advance in astronomical instruments for several dec-

—Photos by National Geographic Society

ROSETTE NEBULA. Enlarged section of a Schmidt photograph showing a portion of the Milky way in the constellation of monoceros.

EDWIN P. HUBBLE, Mt. Wilson astronomer, who will direct the "Big Schmidt" sky survey at Palomar Observatory in California.

ades. Parabolic reflectors like the 200-inch at Palomar have a very small field—only a fraction of a degree—and of that small field only a small area in the center is well defined. Schmidt discovered how to get sharp definition at low focal ratios. He did this by interposing at the center of curvature of a spherical mirror a

thin correcting plate, deformed so as to parabolize the sphere, so to speak. By this means, light rays, first refracted by the correcting lens and then reflected from the mirror, focus uniformly on the photographic plate. For speed and convenience the Schmidt camera serves as the miniature camera of astronomy.

Make Plans for—

National Education Association, July 3–8, Boston, Massachusetts.

American Educational Research Association, July 4, Boston, Massachusetts.

American Veterinary Medical Association, July 11–14, Detroit, Michigan.

1st International Congress of Biochemistry, August 19–25, Cambridge, England.

4th International Conference of the International Association of Quaternary Research, August 22–September 15, Budapest, Hungary.

International Union for the Scientific Study of Population, August 27–September 3, Geneva.

British Association for the Advancement of Science, annual meeting, August 31–September 7, Newcastle-upon-Tyne, England.

15th International Conference of the International Union of Chemistry, September 6–10, Amsterdam, Holland.

SCIENCE

JUNE 24, 1949

LOYALTY AND SECURITY PROBLEMS
OF SCIENTISTS
SCIENTISTS' COMMITTEE ON
LOYALTY PROBLEMS

BIOLOGICAL SYNTHESIS OF
RADIOACTIVE SILK
PAUL C. ZAMECNIK *ET AL.*

TECHNICAL PAPERS

COMMENTS & COMMUNICATIONS

BOOK REVIEWS

NEWS AND NOTES

INDEX ISSUE

AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE